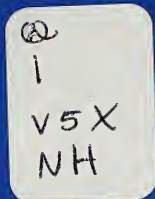


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EDITOR/BUSINESS MANAGER:

James H. Martin

Dept. of Biology - PRC

J. Sargeant Reynolds Community College

P.O. Box 85622

Richmond, VA 23285-5622

Phone: (804)371-3064

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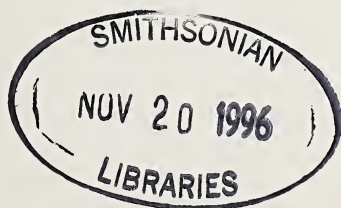
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Nest Box Use By Wild Populations Of White-footed Mice (*Peromyscus leucopus noveboracensis*) In Virginia

C. Richard Terman, Laboratory of Endocrinology and
Population Ecology, Biology Department,
College of William and Mary, Williamsburg, VA 23185

ABSTRACT

A population of white-footed mice on an 11-ha area was studied monthly during 1983-1989 with 600 live-traps and with 254 wooden nest boxes attached to trees. Location, sex, age, body weight, and reproductive condition of individual animals were recorded. Trappability of population animals was greater than 90%. Data from nest boxes were consistent with those obtained via trapping, but rarely did more than 40% of the population occur in the nest boxes. Less than 20% of suckling young recorded in nest boxes were subsequently captured in traps. Use of nest boxes declined to less than 10% of the known population during the summer (May -September). The percentage of the known population in nest boxes was inversely related to the mean minimum monthly environmental temperature. Less than 20% of the population occurred in nest boxes when the monthly mean minimum temperature rose above 8° C.. The data suggest that other nest box techniques, perhaps subterranean nest boxes, will be required to study *Peromyscus leucopus noveboracensis* during the critical mid-summer breeding hiatus (Terman, 1993)

Key Words: White-footed mice, *Peromyscus*, Nest Box

INTRODUCTION

Nest box techniques have been effective in studying the dynamics of *Peromyscus* populations (Goundie and Vessey, 1986; Howard, 1949; Nicholson, 1941; Terman, 1961, 1963, 1968; Wolff, 1986; and Wolff and Durr, 1986). In 1968, I urged in the first "Peromyscus Book" (Terman, 1968) that nest box techniques be utilized to gain greater insight into the behavioral ecology of *Peromyscus* populations because they permit access to young in the nest, many of which may never be recorded in traps. In a recent study of population growth and regulation, both nest box and live-trapping data were available for the same area during the same months for several years (Terman, 1993). This is my attempt to utilize nest box techniques to study wild populations of White-footed mice in southeastern Virginia. I present it here for informational purposes and to suggest that, at least in southeastern Virginia, standard nest box techniques, previously successful elsewhere, may need to be modified.

MATERIALS AND METHODS

Study Area

The study area is part of the approximately 15-ha Ecological Study Area of the College of William and Mary, Williamsburg, Virginia, 37° 03' N, 76° 09' W, adjacent to the Laboratory of Endocrinology and Population Ecology and has been previously

described in Terman (1993). Within the area, I constructed an 11-ha grid provided with 300 trap stations (600 live-traps) placed at 20-m intervals and 264 wooden nest boxes placed at 20-m intervals on trees approximately equidistant from the four nearest trap stations.

The trapping stations are arranged in 13 columns (A-M) on a compass bearing of NE-SW with 24 rows (1-24) in each column except in column A which contains only 12 rows of trap stations. Two single-capture live-traps (7 x 7.8 x 25.5 cms) were placed within a 2-m radius of each station marker. The sides and top of each trap are made of aluminum and the floor is wooden. Each trap has a gravity-fall aluminum door and lock on one end and 0.6 cm hardware cloth on the opposite end.

The nest boxes, patterned after Nicholson (1941) and Howard (1949) (inside dimensions: 14.5 x 14 x 18 cm.), are made of 12.7 mm. plywood. The ceiling of the nest chamber is plywood allowing approximately 3 cm of air space between the nest chamber roof and the top of the box.

The floor of the nest chamber is made of 0.6 cm hardware cloth and is approximately 3 cm above the wooden floor. There are two entrances (2.5 cm diameter) to the nest chamber of each box. Cotton was placed in each box to serve as bedding. Each box was attached by a wooden ramp to a tree at a height of approximately 1.5 m.

Trapping and Nest Box Procedures

Trapping occurred 3 nights each month from February through November from 1983 through 1989. Sunflower seeds were used as bait until 22 April 1988, after which a mixture of vegetable shortening and peanut butter was used.

Nest box inspections were spaced at irregular intervals from May to October and approximately monthly during the rest of the year.

The use and availability of the nest boxes varied over the study. Only 124 of the eventual 264 nest boxes were available from March 1983 until November 1984. In January 1989, vandals destroyed 111 nest boxes on the study area. It was not possible to get all of these repaired until early 1990 so nest box data for 1989 are not evaluated here.

At each inspection or trapping period, the following data were collected: date, time, weather (cloudy, rain, wind), temperature, traps disturbed (turned over) or sprung, species captured, animal number (individuals numbered by toe clipping) and trap location, sex, age class (adult, young adult, juvenile, young in nest), body weight, and reproductive condition (females: pregnant, lactating, vagina open or closed; males: testes scrotal or non-scrotal). Age classes were based on pelage color with adults brown, young adults molting from gray to brown and juveniles uniform gray.

RESULTS

Population Numbers

Greater than 90% of the mice known to be on the area each month were captured in live traps even though population numbers on the study area varied widely over the seven years of this study (1983-1989) (Terman, 1993).

Nest Box Use

The data on adult or young adult population animals obtained from the nest boxes were generally consistent with those obtained via trapping, although the absolute

numbers recorded were smaller. Nest box use was greatest from November through March of each year. Suckling young were found in the nest boxes most frequently from November through March of each year but less than 20% of them were subsequently captured in traps. Calculation of the mean monthly percentage of adult animals captured in the nest boxes during months when both trapping and nest box inspections occurred showed that only rarely did more than 40% of the known population occur in the nest boxes and this occurred primarily in February and March (Figure 1). Typically, during the summer (approximately May through September), less than 10% of the known population was recorded in nest boxes (Figure 1).

Temperature Records

Figure 1 also presents data on the mean + the standard error of monthly minimum temperature during the seven years of this study recorded at a weather station maintained by the National Climatic Data Center within approximately two miles of the study area. Low nest box occupancy (less than 20% of the population) occurred when the monthly mean minimum temperature rose above 8° C. Correlation analysis showed a significant negative correlation ($r = -0.9421$; $P < 0.001$) between mean minimum monthly temperatures and the monthly percentage of the known population in nest boxes.

DISCUSSION

Nest box utilization was markedly and consistently reduced during the summer months (April through October, Figure 1) in Southeastern Virginia during the seven years of this study. This decline in nest box use is negatively correlated with temperature increases even under a forest canopy (Terman, 1993). However, other factors may be important such as the high humidity coupled with the high average temperature typical for this time of year in southeastern Virginia. Little information is reported from previous nest box studies on the influence of increased environmental temperature on nest box use. Most attention has focused on the influence of lower environmental temperatures.

Nicholson (1941) used wooden tree boxes and ground boxes to study *P. leucopus noveboracensis* in southern Michigan and gave no indication of significant variation in the use of his nest boxes throughout the year although the number of nest boxes he used was small (64). Goundie and Vessey (1986) used 91 wooden tree boxes on a 2 ha isolated woodlot in Ohio to study *P. leucopus noveboracensis* from January through November, 1980. They recorded high use of the boxes and gave no indication of significant seasonal variation. Wolff (1986) and Wolff and Durr (1986) used 60 wooden nest boxes (both tree boxes and boxes placed on the ground) in the Allegheny mountains of southwestern Virginia to study both *P. leucopus noveboracensis* and *P. maniculatus*. The boxes were inspected, however, only from November, 1984 through March 1985, but were not used by the mice during the coldest part of the winter (February).

Some variation in the use of nest boxes related to placement and season of year has been shown in some previous studies of *Peromyscus leucopus noveboracensis*. Nicholson (1941) and Howard (1949) have presented data indicating lesser use of arboreal boxes and greater use of ground level or subterranean boxes during the colder months. Telemetry studies in which animals are traced to their natural nests have

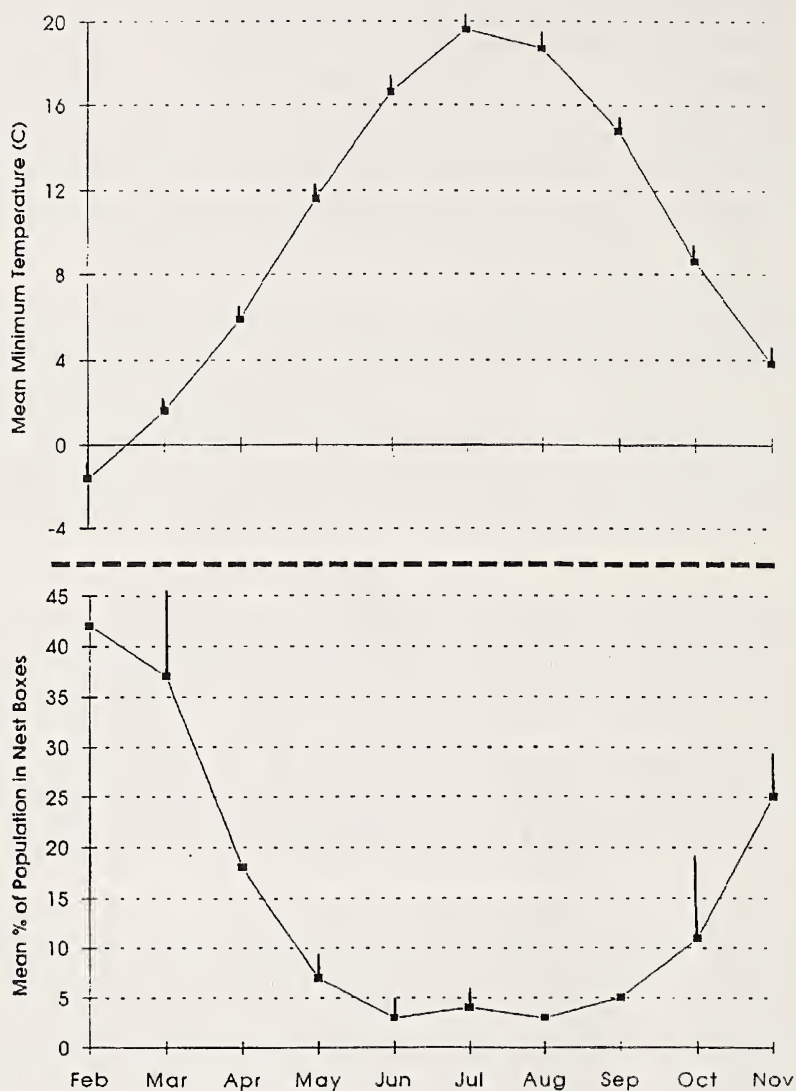


FIGURE 1. The monthly mean minimum temperatures (C) + SE and the monthly mean percentages + SE of the white-footed mouse population in nest boxes during 1983-1989.

shown increased use of subterranean nests compared to arboreal nests during the colder months of the year (Madison, Hill, and Gleason, 1984; Wolff, 1986; Wolff and Durr, 1986; Wolff and Hurlbutt, 1982) Data on differential use of nest boxes during the summer were not definitive and it may be that the negative impact of higher temperature on nest box use is not evident in higher elevations or more northern locations. Nest

box techniques are important for wild population studies of small mammals and additional examination of environmental variables including temperature is needed.

Low use of nest boxes during the summer months is a significant impediment to utilizing them to study the as yet unexplained reproductive hiatus in reproduction described for White-footed mice in southeastern Virginia (Terman, 1993). One possible solution to this problem may be to utilize subterranean nest boxes.

ACKNOWLEDGMENTS

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The Composition of Copper Recovered from Contact Native American Sites in the Lower Piedmont and Southern Ridge and Valley, Virginia

Michael B. Barber, Preservation Technologies, Inc., P.O. Box 921, Salem, Virginia 24153, **Todd N. Solberg**, Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, and **Eugene B. Barfield**, Preservation Technologies, P.O. Box 921, Salem, Virginia, 24153.

ABSTRACT

Excavations at three Native American Late Woodland village sites along the Roanoke (Staunton) River in the Piedmont and Ridge and Valley of Virginia yielded artifacts of copper. Associated with European glass beads and iron trade goods, the origin of the copper, whether American or European, would have far reaching cultural implications. Copper analyses on specimens from two of the sites using a scanning electron microscope indicated that the copper was a smelted alloy and of European origin. Comparison with other Virginia sites suggested an ornamental use of copper at the tribal level of social organization in the western part of the Commonwealth as opposed to use as status markers in the chiefdom level societies to the east. The minimal effect of the trade goods on Native American cultures in the Piedmont and to the west during the period of European contact was underscored.

INTRODUCTION

Cultures in contact have always been an inspiring topic in anthropology. Within the context of Virginia, much time and many studies have focused on the first serious interactions of the state level English colonials at Jamestown and the indigenous chiefdom level Powhatans (eg. - Fausz, 1985; Turner, 1976, 1982, 1985; Potter, 1982, 1990; Feest, 1978; Rountree, 1989, 1990). As Jones (1989) points out, within a week of the selection of Jamestown Island as the second English settlement in the New World, the colonials documented first contacts with the Indians of the interior. The next historic reference to these tribal groups occurred after a 63 year hiatus when a German doctor, John Lederer, was commissioned to travel into the unknown wilds of Virginia in 1670 (Alvord and Bidgood, 1912). Following closely behind were Batts and Fallom in 1671 who were in search of the western waters and likely traveled as far as the New River (Alvord and Bidgood, 1912; Barber and Barfield, 1992) but may have reached what is now West Virginia (Briceland, 1987). In any case, the ethnohistoric information for the Native Americans of the interior during the seventeenth century is meager at best. Hence, it falls to the archaeological study of the remains of material culture to provide for an understanding of the period in areas to the west. Recent discoveries in the lower Piedmont and southern Ridge and Valley of the Commonwealth along the Roanoke (Staunton) River include three sites (44PY144, 44RN39, and 44RN21) dating to the contact period. These sites have led to a better understanding of the dynamics of the period (Klatka, 1992, 1993; Barber, 1988, 1993).

The recovered European trade assemblages from the sites have been previously discussed (Barber, 1994) and include glass beads, iron artifacts, shell disk beads, and copper tags, beads, and scrap fragments. It is the purpose of this paper to present the preliminary results of the chemical examination of one of these artifactual materials, copper.

RESEARCH DESIGN AND METHODOLOGY

In general, the compositional study of copper recovered from the Hurt Power Plant Site (44PY144) in the Piedmont of Pittsylvania County and that collected from the Ridge and Valley Thomas-Sawyer site was undertaken to lend insight into the cultural nuances in operation during the period of contact. Research questions can be expressed as follows:

1. Were the recovered copper artifacts of Native American or European origin? Their association with glass beads suggests a European source; however, recent studies at other Virginia sites (ie.- Pasbahegh ,JC308) has proven that a mix of American and European copper cannot be ruled out.
2. Is the copper homogeneous in nature on the contact sites or is variation inherent? Are the copper trade goods chemically consistent on individual sites?
3. What are the cultural implications for the chemical make-up of the copper artifacts at the regional and global levels?
4. What methodology might be the most appropriate for the study of copper artifacts? Various study techniques have been brought to bear on these artifacts with various results; which techniques have the highest potential for the production of relevant data?

In order to ascertain at least some of the answers to the above questions, a methodology was implemented which involved the study of the copper artifacts using a Scanning Electron Microscope (CamScan S.E.M Series 2, HNU System, EDS System 5000) for elemental analysis. The copper material was first examined in a natural state with no alteration of the artifact. Results were limited to the artifact surface and determined that the surface of the artifact was copper sulfate - in essence, a naturally forming patina. As it was information on the overall composition which was required not just the oxidated exterior, a regime of preparation was opted for which would expose the artifact interior for testing. The copper artifacts were first examined for stability and those of a fragile nature currently eliminated from testing. Should the data from these artifacts prove necessary for the study, various reversible embedding techniques can render the artifacts stable enough for analysis.

Preparation involved carefully removing the patina from a small portion of the surface and exposing the base material. This was accomplished through grinding on fine grade emery cloth with further polishing with one micron diamond dust. Usually an edge was polished with the patina removed from an area less than 5 mm in length. The artifact was then mounted and placed within the SEM for composition analysis. Although the normal examination provides for bulk elemental analysis, certain elements which the authors felt were of importance were programmed for minute consideration. These included copper, zinc, tin, lead, silver, nickel, antimony, and arsenic. In theory, this approach would provide for the widest range of natural and added elements. A minimum of 4 readings were taken for each artifact. SEM readings were programmed to provide for a 100 live second analysis. This was opted for in

order to eliminate dead time, regularize the time of readings, and to provide adequate time for sampling. The majority of readings were taken as spot readings with the microscope focusing on one minute area of the artifact. Bulk reading were also taken sporadically but provided similar results. Due to the nature of the SEM, it should be cautioned that results are possibly more qualitative than quantitative; however, consistent readings suggest that results have an accuracy adequate for this type of study.

As the SEM allows for magnification to roughly 3000 times, inconsistencies in artifact composition can be noted. In the case of copper, non-incorporated inclusions could be identified. Composition readings were taken on those particles as well as the more homogenous parent body.

RESULTS OF ANALYSIS

Two sample artifacts were run for the Thomas/Sawyer Site (44RN39). This site is located in Salem, Virginia, and has a minimum of 6 occupation episodes. The last was a proto-historic hamlet occupation with radiocarbon dates of A.D. 1600 ± 90 and A.D. 1630 ± 90 . One glass bead, 5 pieces of iron wire, one iron needle, and 7 pieces of copper were found within an undisturbed Native American context. Elemental readings are presented in Tables 1 and 2. Copper was consistently the highest in composition with circa 66% to 69%. Zinc was next accounting for roughly 28% to 29%. Lead made up from 1.58% to 2.14%. Remaining elements were incidental. The inclusions are of interest and are high in lead content - 24% to 40% overall. Hence, the make-up of the copper artifacts recovered from the Thomas/Sawyer site is roughly 2/3 copper and 3/10 zinc with particles of lead within the matrix. As Klatka (1992) relates, this mix of copper and zinc is identified as the alloy yellow brass.

At present, 8 copper artifacts from the Hurt Power Plant Site have been analyzed. The major village site likely dates to the period later than the Thomas/Sawyer site, probably resting between A.D. 1630 and A.D. 1650. Two copper compositional patterns were found: the first included 6 artifacts and the second 2 artifacts. Within the first group, as seen in Tables 3 and 4, copper accounts for 95% to circa 97% of the alloy. Zinc and lead compete for the second most frequent element at usually 1% to 2%. Inclusions were also noted within this category. Of interest, the particles noted were high in antimony - 63% to 66%. Antimony is an additive which aids in the temperature contraction and expansion process. In addition, in two of the examples, the antimony formed elongated stringers the result of a rolling process of manufacture.

The second pattern closely resembles the Thomas/Sawyer copper as presented in Table 5. Copper content rests at circa 65% with zinc at roughly 33%. Inclusions are lead with a reading varying from 24% to 44%. Hence, the Hurt Power Plant Site contains copper of a yellow brass as well as a purer variety copper containing particles of antimony.

DISCUSSION

The copper artifacts recovered from the earlier Thomas/Sawyer Site (44RN39) are of a brass with a two-thirds copper and just less than one-third zinc composition. The artifacts from the slightly later Hurt Power Plant Site (44PY144) exhibit 2 patterns: the first and most numerous were of an almost pure copper with a low content of zinc and/or lead with inclusions of antimony. Artifacts of the second category exhibit the Thomas/Sawyer pattern of two-thirds copper and one-third zinc with lead inclusions.

TABLE 1. SEM Analysis of Copper Artifact CU2 from Thomas/Sawyer Site (44RN39).

44RN39 FEATURE 5 (West 1/2, Level 2) CU2		
Copper artifact - Triangular in shape (21.60 mm L, 7.25 mm W, 0.57 mm T)		
SEM POSITION	ELEMENT	WEIGHT %
SURFACE	Cu	67.99
	Zn	28.76
	Pb	2.14
	Ni	0.61
	Al	0.33
	Mg	0.17
SURFACE	Cu	65.82
	Zn	28.21
	Pb	2.86
	Mg	1.99
	Ni	0.67
	Al	0.45
INCLUSION	Cu	36.60
	Pb	24.37
	Zn	17.27
	S	10.16
	Al	4.18
	Si	3.82
	P	2.94
	Ni	0.66
INCLUSION	Pb	40.88
	Cu	29.86
	Zn	17.61
	S	9.04
	Al	2.61

While it is obvious that the analysis has determined that 2 different manufacturing techniques for copper alloy are present, the implications remain a bit murky. As with most aspects of archaeological study, the important variables are time, space and technology. Are the different alloys tied to different production origins with varied raw material availability? Or it is possible that production innovations through time led to metallurgical advances which altered recipes? And finally, were different alloys used in different products? While this is obviously true in the range of functional artifacts produced by Europeans for their use, what were the "products" from which the rolled beads and tags were manufactured? If these hypotheses are to be tested, it is required to extend the study through Jamestown to England and the rest of Europe in order to reconstruct manufacturing patterns during the late sixteenth and seventeenth century.

TABLE 2. SEM Analysis of Copper Artifact CU3 from Thomas/Sawyer Site (44RN39).

44RN39 FEATURE 5 (East 1/2 Level 2) CU3		
Copper Artifact - Rectangular in shape (21.17 mm L, 8.46 mm W, 0.53 mm T)		
SEM POSITION	ELEMENT	WEIGHT %
SURFACE	Cu	68.96
	Zn	28.71
	Pb	1.58
	Ni	0.66
	Al	0.07
	Fe	0.02
INCLUSION	Cu	31.68
	Pb	27.19
	Zn	20.56
	S	8.59
	Al	6.92
	As	2.81
	Si	2.25
INCLUSION	Pb	37.60
	Cu	34.87
	Zn	20.75
	Al	4.28
	Si	2.48
	P	0.01

When considering patterns within a Virginia context, two other analyses of copper are of interest. The first included 5 samples recovered in a sealed Native American context at the third-quarter seventeenth century contact occupation at the Graham/White site, Ridge and Valley village site found in Salem, Virginia, within one-half mile of the Thomas/Sawyer Site. These artifacts were analyzed for elemental composition through inductively coupled plasma emission spectrometry. This technique has the advantage of high resolution, accurate results but the disadvantage of complete artifact destruction. The Graham-White specimens were found to contain between 64% and 70% copper with a zinc content between 26% and 33% (Klatka, 1992). This "yellow" brass appears to be very close in make-up to the material at Thomas/Sawyer and the minority copper at the Hurt Power Plant Site.

Copper analysis was also implemented on 31 artifacts from the Governor's Land excavations at 44JC308. This site was the prehistoric and contact village of Pasbehey on the James River. The copper assemblage tested was made up of 28 tubular beads, 1 ring bead, and 2 pendants. Of interest here is the analytical technique of Proton-Induced X-ray Emission (PIXE) spectrometry. Due to high copper purity, 8 artifacts were determined to be of Native American origin. The remaining 23 artifacts are also high in copper purity but contained lead, antimony, and nickel impurities. Fleming

TABLE 3. SEM Analysis of Copper Artifact CU51 from Hurt Power Plant Site (44PY144).

44PY144 Feature 89 (North 1/2 Level 2) CU51		
Copper artifact - Rolled bead (5.48 mm L, 2.75 mm W)		
SEM POSITION	ELEMENT	WEIGHT %
SURFACE	Cu	95.25
	Pb	1.76
	Zn	1.30
	Ni	0.78
	Al	0.74
	Mg	0.44
SURFACE	Cu	97.18
	Zn	1.23
	Al	0.63
	Pb	0.54
	Ni	0.42
INCLUSION	Sb	63.21
	Cu	21.59
	Pb	9.80
	Ca	2.24
	Zn	2.08
	Al	0.70
	Ni	0.37
INCLUSION	Sb	52.59
	Cu	32.73
	Pb	9.41
	Zn	1.99
	Ca	1.89
	Al	0.90
	Ni	0.49

and Swann (1994) indicate that the "compositions and ranges" so closely resemble European patterns for smelted copper that they are surely of European origin. The composition for the European artifacts compares favorably to the majority group from the Hurt Power Plant where copper content is in the 95 to 97 percentile with lead and nickel in low percentage and antimony inclusions noted. The presence of circa 1.0% of zinc, however, may eventually place the Hurt artifacts in a different category.

The trade of copper at the Governor's Land on the coastal plain consisted of smelted copper, the artifacts recovered in the lower Ridge and Valley brass, and those recovered in the southern Piedmont of brass and purer copper. Studies of sixteenth century Iroquoian artifacts have led to the recognition of similar mixes of brass and purer copper with ties to 2 trade networks, the Basque purer copper trade and the Norman brass trade (Bradley and Childs, 1991). Although these sources are of interest, the varied history

TABLE 4. SEM Analysis of Copper Artifact CU32 from Hurt Power Plant Site (44PY144).

44PY144 Feature 28B (West 1/2 Level 3) CU32		
Copper artifact - Scrap (38.65 mm L, 7.24 mm W, 0.40 mm W)		
SEM POSITION	ELEMENT	WEIGHT %
SURFACE	Cu	97.65
	Zn	1.02
	Al	0.82
	Ni	0.32
	Pb	0.15
	As	0.05
SURFACE	Cu	97.26
	Zn	1.04
	Al	0.88
	Pb	0.52
	Ni	0.30
INCLUSION	Sb	66.84
	Cu	21.70
	Pb	4.85
	Ca	2.49
	Zn	1.56
	Al	1.39
	As	1.04
	Ni	0.13
INCLUSION	Sb	61.44
	Cu	22.42
	Pb	11.03
	Ca	2.34
	Zn	1.81
	Al	0.81
	Ni	0.14

of European settlement along the Atlantic seaboard suggests that alternate sources of trade goods would be in play in a Virginia context.

CONCLUSION

The copper and copper alloy artifacts recovered from the Hurt Power Plant site and the Thomas/Sawyer site are definitely of European origin consisting of smelted copper and brass. While only brass has been identified at Ridge and Valley Thomas/Sawyer and Graham-White, purer copper as well as brass was present at the Piedmont Hurt Power Plant Site. Studies to the north suggest that different trading networks may have brought artifacts of different composition. While in the latter seventeenth century this might reflect differences in commerce between the Virginia trade and the Carolina trade, the earlier periods would likely be tethered to indirect

TABLE 5. SEM Analysis of Copper Artifact CU22 from Hurt Power Plant Site (44PY144).

44PY144 Feature 2 (West 1/2) CU22		
Copper artifact - Scrap (6.72 mm L, 2.72 mm W, 0.45 mm W)		
SEM POSITION	ELEMENT	WEIGHT %
SURFACE	Cu	64.77
	Zn	33.62
	Al	0.84
	Pb	0.61
	Ni	0.16
SURFACE	Cu	64.61
	Zn	33.93
	Pb	0.82
	Al	0.41
	Ni	0.24
INCLUSION	Pb	44.18
	Cu	29.39
	Zn	20.37
	Al	5.17
	Si	0.90
INCLUSION	Cu	37.40
	Pb	24.16
	Zn	23.92
	Al	5.81
	Si	3.71
	P	2.82
	As	2.16
	Ni	0.02

trade to Jamestown. As such, the Virginia Company and later Jamestown sources as well as products deemed appropriate for trade with the Native Americans are of interest.

A varied battery of techniques are being brought to bear on the analysis of copper artifacts in order to determine chemical composition. While these techniques are all applicable in differentiating European from Native American copper, the varied analytical techniques lead to varied sets of data. These sets are not particularly comparable and, hence, certain similarities and contrasts may not be apparent. Some techniques are likely better than others. For example, plasma emission spectrometry requires that the artifact be liquified leading to complete destruction. As PIXE analysis relies heavily on surface composition, it is not particularly well geared for an analysis of base metal composition. Likewise, the scanning electron microscope has its drawbacks as it is felt to be more qualitative than quantitative. Future work with the electron microprobe may prove of highest accuracy. In any case, archaeologists, geologists, and metallurgists dealing with archaeological remains will need to swallow the bitter

portion and regularize their analytical approaches in order to produce comparable data in the future.

Scholars have long examined the role of and the evolution of copper exchange within the Commonwealth. More recently, Potter (1989) has demonstrated the importance of copper artifacts as symbols of status for the late prehistoric Native Americans on the coastal plain of Virginia. Hantman (1990) has made a case for the exchange of copper from the interior of Virginia (and possibly beyond) by a Monacan chiefdom to the Powhatan. Whether traded by the Monacan or others, the prehistoric flow of copper in prehistoric times was from west to east. At contact, however, the pattern reversed with small amounts of European copper making its way into the interior. While the ornamental copper pieces never reached the social importance seen at the chiefdom level to the east, copper was a sought after accoutrement by the tribal groups of the interior. An increased understanding of its chemical composition can only lead to an increased understanding of trade networks and cultural contact through time.

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Habitat Fragmentation and the Perceived and Actual Risk of Predation

Stephen F. Matter, John F. Zawacki, and Michael A. Bowers,
Department of Environmental Sciences, University of Virginia,
Charlottesville, VA 22903 and The Blandy Experimental Farm
Boyce, VA 22620

ABSTRACT

We used live-trapping and tethering trials to evaluate differences in both predatory risk assessment and actual predatory events for two small mammal species in fragmented and unfragmented (control) landscapes. We found no difference between the mean number of individuals captured in the fragmented or unfragmented landscapes for either species, however *Peromyscus leucopus* tended to be captured less frequently near patch edges in the fragmented treatment; *Microtus pennsylvanicus* did not exhibit this response. The total number of predatory events was low over both the fragmented and unfragmented landscapes. Two confirmed predation events, out of a total of 40 trials, occurred in the unfragmented landscape suggesting if any difference in actual predation risk exists it may be greater in continuous than in fragmented landscapes. The combination of these results indicates that edge avoidance may be an innate response to habitat structure rather than to the actual risk of predation.

INTRODUCTION

Habitat fragmentation has been shown to lower species abundance/density, increase the probability of local extinction, and alter community structure (for reviews see Simberloff, 1988; Saunders et al., 1991). Several studies have also suggested that predation may be greater in fragmented than in continuous habitats. Andrén et al. (1985) reported that predation by corvid birds on artificial nests resembling those of woodland grouse tended to increase with increasing amount of fragmentation, and demonstrated that the proportion of nests preyed upon within woodlot fragments increased towards habitat edges (Andrén and Angelstam, 1988). Increasing woodlot fragmentation also resulted in increased corvid density (Andrén, 1992). However, because the preferred habitat of corvids, cropland, also increased with woodlot fragmentation it is not clear whether increasing densities were related to fragmentation *per se* or changes in habitat. Bowers and Dooley (1993) found seed removal by small mammals, particularly during full moon periods, to be higher in patch interiors than on patch edges, and interpreted this as a predator avoidance response.

From the perspective of a prey species, predation can be partitioned into two distinct components: the perception of predatory risk and actual predation. It is important to note that avoidance of areas perceived to be 'risky' may be an innate behavioral response and unrelated to the actual risk of predation or an individual's experience e.g. the general avoidance of open areas by small mammals (Lima and Dill, 1990). Separating these components of predation is important. Actual predation may be a rare event, however the impact of predation on an individual basis is quite severe. Hence

we may expect behavioral responses to be overly sensitive to regions of differing predatory risk.

Habitat fragmentation may affect both the perceived risk of predation and the actual rate of predation. Because fragmentation often results in the imposition of habitat edges, if a prey species perceives habitat edges or ecotones to be 'riskier' areas, these areas may be avoided and under-utilized, whereas habitat interiors may be viewed as safer and proportionally over-utilized (Bowers and Dooley, 1993). A variety of mechanisms have been proposed to account for greater predation rates in fragmented habitats. Success by 'edge predators' that forage on habitat peripheries may be increased by the introduction of habitat edges (Andrén and Angelstam, 1988). Fragmentation may also create localized patches containing prey species that can be more efficiently exploited by predators (Weins, 1976; Taylor, 1976a). Finally, habitat fragmentation may increase the diversity of a landscape thereby increasing the number of predatory strategies that can be supported, ultimately increasing the overall predation rate (Wolff, 1980; Keith, 1983; Andrén et al., 1985; Andrén, 1992).

The main objective of our research was to examine behavioral responses possibly related to predator avoidance in relation to the actual predatory risk for small mammals residing in fragmented and unfragmented landscapes. Based on previous work by Bowers and Dooley (1993), we hypothesized that in a fragmented landscape patch edges would be avoided and that predation rates would be greater than in a similar continuous landscape.

METHODS

We conducted our study June through August 1993, at the University of Virginia's Blandy Experimental Farm (BEF) located in the Northern Shenandoah Valley, Clarke County, Virginia. The study site was a 20 ha old-field, bounded by a 50 ha mature oak-hickory woodlot, the Orland E. White arboretum, and a commercial alfalfa field. Prior to 1986 the site was used primarily as pasture, but has been unmanaged since. Subsequently, the field has come to be dominated by successional species such as *Carduus acanthoides*, *C. nutans*, *Celastrus scandens*, and *Rhus radicans* as well as several grasses eg. *Dactylis* sp., *Agrostis* sp., and *Festuca* sp. (for a complete vegetational description see Bowers, 1993).

Study Species

The meadow vole (*Microtus pennsylvanicus*) and the white-footed mouse (*Peromyscus leucopus noveborcensis*) were the dominant small mammals. Although *P. leucopus* is generally considered a woodland species, at BEF it also inhabits early-successional old-fields (Halama, 1989; Dooley, 1993; Bowers and Dooley, 1993).

Mammalian predators observed at BEF include: red fox (*Vulpes vulpes*), striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), and feral cats (*Felis catus*). The northern short-tailed shrew (*Blarina brevicauda*) was occasionally captured during trapping and has been reported as a predator of juvenile *Microtus* (Getz et al. 1992). Avian predators include red-tailed hawks (*Buteo borealis*) and barn owls (*Strix pratincola*). Snakes and other predators capable of feeding on *Peromyscus* or *Microtus* are seldom observed at BEF, but may also be present.

Experimental Design and Trapping Protocol

We established eight 50 x 50 meter patches/grids: four patches were in a fragmented treatment, isolated from other patches and surrounding vegetation by 25m wide mowed areas; and four trapping grids within unmanipulated, continuous vegetation which served as controls (Figure 1). The arrangement of patches/grids in the fragmented and unfragmented treatments was not identical due to logistic constraints. Twelve large folding Sherman live traps were used per patch/grid to quantify habitat use by small mammals. One trap was placed at each corner of each patch/grid, one on the middle of each side, and four traps, separated by 10 m, in the interior (each interior trap was 25 m from the nearest corner). This pattern provided four interior traps, four traps on edges, and four traps on the corners of each patch/grid. For patches, corner traps were surrounded by 25 % cover, and edge traps by 50 % cover. Corner and edge traps for grids and all interior traps were completely surrounded by unmanipulated vegetation. Vegetation around patches was initially mowed one month before trapping began, and subsequently when vegetation reached 12 cm in height.

Live trapping was conducted once per week from July 6 to August 3, 1993. Traps were baited with peanut butter approximately 2 hours before sunset and checked at dawn the following morning. Upon initial capture, individuals were tagged and toe-clipped for identification, and species, sex, age, reproductive condition, and weight were recorded. Between trapping sessions traps were locked open to allow free exploration.

To assess actual predation risk between the experimental landscapes, *Peromyscus* captured in a nearby woodlot were tethered using 20 cm of steel cord secured to the ground. To exclude avian predation and allow for identification of terrestrial predators, mice were also tethered in a similar manner within large Hav-a-heart traps. Each patch/grid had one tethering station on a randomly selected edge. Two patches/grids within each landscape had open tetherings while the other two patches/grids had avian exclusion tetherings. Five trials were run, totaling 40 tetherings. Mice were tethered in the evening prior to baiting and checked the following morning. Mice were scored as surviving, injured, preyed upon (evidence of remains), or missing (either escaped or no evidence of predation).

Statistical Analyses

To evaluate differences in spatial usage patterns between landscapes, we examined the proportion of captures at each trap type (corner, side, or interior) using repeated measures analysis of variance (RMA). Trap location and landscape type were the between subjects factors while trapping date was the within- subjects effect. Data were expressed as the proportion of captures at each trap type, and were angularly transformed prior to analyses (Sokal and Rohlf, 1981). To test for differences in abundance between fragmented and unfragmented landscapes, the mean number of individuals captured per patch/grid was evaluated using Student's t-test. All tests were conducted separately for each species.

RESULTS

Over seven trap sessions (672 trap nights), 75 *Peromyscus* and 92 *Microtus* individuals were captured a total of 136 and 110 times, respectively. No difference in the mean number of individuals captured over the seven trap periods in fragmented

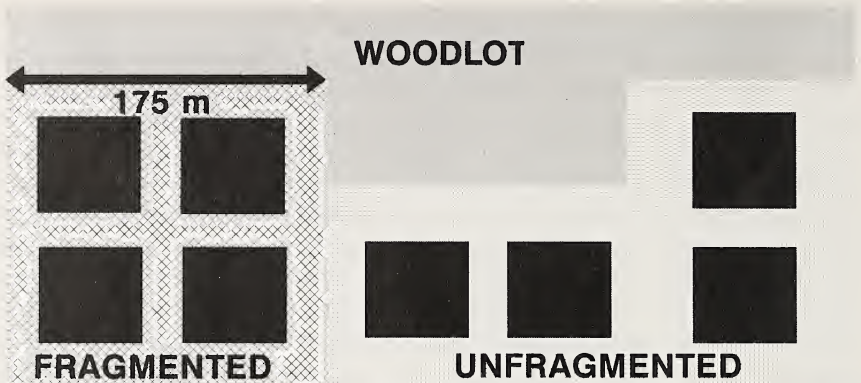


FIGURE 1. Experimental design and landscape configuration. Dotted areas indicate unmowed vegetation (unfragmented), while cross-hatched regions indicate mowed vegetation (fragmented). The grey area represents an oak-hickory woodlot. Solid black squares symbolize trapping grids within the continuous region and patches within the fragmented region. Each patch/grid was 50 x 50 m, and separated from the nearest patch/grid by 25 m.

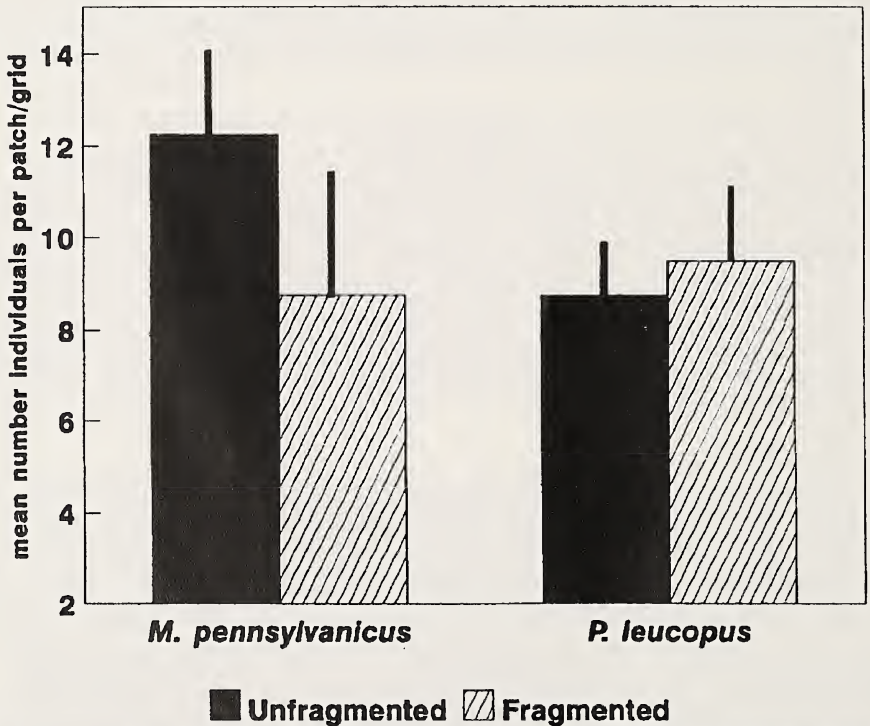


FIGURE 2. Mean number of individuals (\pm SE) trapped within patches in the fragment and control landscapes over the seven trap periods.

versus unfragmented patches was found for either *Microtus* ($t=0.82$, $df=6$, $p=0.44$) or *Peromyscus* ($t=-0.13$, $df=6$, $p=0.90$) (Figure 2).

TABLE 1. Analysis of variance table based on the mean proportion of traps occupied by *Peromyscus leucopus* (arcsine square root transformed). Main effects tested were fragmentation (frag) and trap position (corner, side, interior) (zone). Trapnight (nite) was the within subjects factor.

Source of Variation	SS	DF	MS	F	P
WITHIN CELLS	3.19	18	0.18		
CONSTANT	21.32	1	21.32	120.19	0.000
FRAG	0.03	1	0.03	0.19	0.669
ZONE	0.27	2	0.13	0.76	0.483
FRAG BY ZONE	1.26	2	0.63	3.54	0.050
Within-Subject Effect					
Source of Variation	SS	DF	MS	F	P
WITHIN CELLS	9.31	108	.09		
NITE	2.08	6	0.35	4.02	0.001
FRAG BY NITE	0.62	6	0.10	1.21	0.308
ZONE BY NITE	0.69	12	0.06	0.67	0.776
FRAG BY ZONE BY NITE	0.32	12	0.03	0.31	0.989
(Huynh-Feldt Epsilon = 1.00000)					

TABLE 2. Analysis of variance table based on the mean proportion oftraps occupied by *Microtus pennsylvanicus* (arcsine square root transformed). Main effects tested were fragmentation (frag) and trap position (corner, side, interior) (zone). Trapnight (nite) was the within subjects factor.

Source of Variation	SS	DF	MS	F	P
WITHIN CELLS	4.18	18	0.23		
CONSTANT	12.90	1	12.90	55.48	0.000
FRAG	0.13	1	0.13	0.56	0.463
ZONE	0.30	2	0.15	0.64	0.541
FRAG BY ZONE	0.54	2	0.27	1.15	0.339
Within-Subject Effects					
Source of Variation	SS	DF	MS	F	P
WITHIN CELLS	9.63	108	0.09		
NITE	3.64	6	0.61	6.81	0.000
FRAG BY NITE	0.49	6	0.08	0.92	0.486
ZONE BY NITE	0.60	12	0.05	0.56	0.869
FRAG BY ZONE BY NITE	0.65	12	0.05	0.60	0.835
(Huynh-Feldt Epsilon = 1.00000)					

Analyses of the proportion of captures revealed some effects of habitat edges. While the tests for the main-effects of fragmentation and trap location alone were not significant for either species there was a significant interaction term involving fragmentation and trap location for *Peromyscus* (Tables 1 and 2). The mean proportion of captures was highest in patch interiors, and lowest at corners in the fragmented

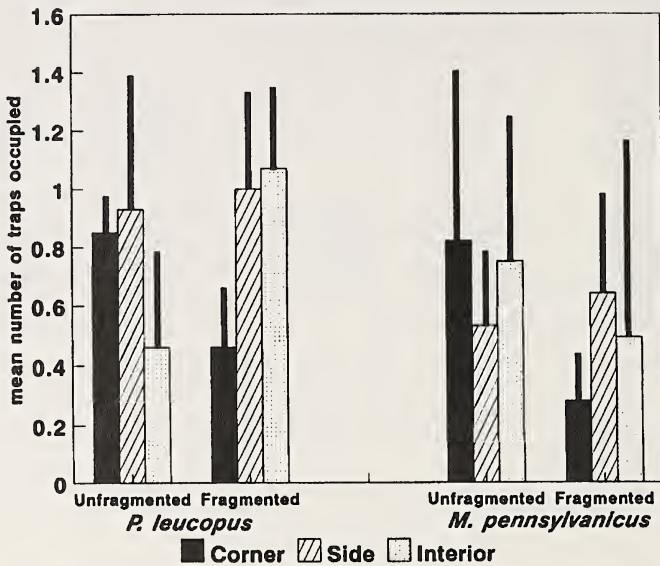


FIGURE 3. Results comparing the mean (SE) number of traps occupied, either corner, side, or interior, in fragmented or unfragmented landscapes for *P. leucopus* and *M. pennsylvanicus*. Bars represent the mean across all trap sessions.

landscape, while in the continuous landscape captures were higher on sides and corners than for interiors (Figure 3). Analyses of *Microtus* captures showed no significant main or interaction effects, but the smallest proportion of captures was on corners of patches in the fragmented landscape. The within-subjects factor, trapping date, showed significant effects for both species resulting from an increasing number of captures throughout the study, but no significant interaction with any main effects factor.

Five nights of predatory trials (8 replicates per trial) resulted in one missing mouse, one wounded mouse, and two confirmed predatory events (one striped skunk was caught in a Hav-a-heart trap containing a tethered mouse, while one event was an open tethering and the predator could not be identified) all within the control landscape. All mice tethered in the fragmented landscape were unharmed.

DISCUSSION

These results suggest that predation rates did not greatly differ between fragmented and continuous habitats, and if any trend actually exists predation rates may be greater in continuous than in fragmented landscapes. This result is contradictory to previous studies, where predation levels were greater in fragmented landscapes or at habitat edges (Andr n et al., 1985; Andr n and Angelstam, 1988; Andr n, 1992). Several factors may be operating in conjunction to produce the observed predation results. The lack of greater predation in the fragmented landscape may result from predators also avoiding open areas where they too may be at risk. Alternatively, predators may be responding to the distribution of prey. Habitat fragmentation produces a distribution of prey that is highly clumped. And this clumping of prey may be further exacerbated by edge avoidance behavior creating prey-poor areas within habitat patches. If

fragmentation produces a coarse 'grain' distribution of prey and predators are adapted to a uniform distribution of prey, then fragmentation may actually reduce rates of predation (Vine, 1971; Taylor, 1976b; Weins, 1976; Kareiva, 1987; Turchin and Kareiva, 1989).

Although actual predation rates were roughly equal in both landscapes, within the fragmented landscape, *Peromyscus* tended to avoid patch edges which is consistent with the notion that the perceived risk of predation is higher in the fragmented landscape (Bowers and Dooley, 1993). Given that fragmentation produced no difference in abundance between landscapes, but resulted in the avoidance of edges, implies that most activity of animals was concentrated in the interior regions of patches in the fragmented landscape. Thus, edge avoidance behavior may increase intra- and inter-specific interactions in fragmented habitats thereby eliciting changes in social and community structure. However, the mechanism of edge avoidance may be unrelated to the actual risk of predation.

It is difficult to explain why *Peromyscus* avoided edges while *Microtus* did not. Part of the explanation may be related to microhabitat preferences. *Peromyscus leucopus* is typically a woodland species, whose microhabitat contains a high degree of vertical stratification and whose movement is generally restricted to protected areas (Barnum et al., 1992). *Microtus pennsylvanicus* is typically found in grassy habitats (Klatt and Getz, 1987), and although Desy et al. (1990), found that increased vegetative cover decreases the risk of predation for *M. pennsylvanicus*, the difference between mowed vegetation and preferred cover for *Peromyscus* is probably much greater than for *Microtus*. A second possibility may be that *Microtus* is more tolerant of edges. This finding is in accordance with those of Harper et al. (1993) and Dooley (1993), who found that densities of *Microtus pennsylvanicus* were unaffected by habitat patch shape (a varying edge to interior ratio), which would be expected if edge avoidance were not a strong factor. A third possible factor relates to the use of space and home range position. Traps may not be equal in their accessibility to small mammals. Traps at corners of unfragmented patches may be encountered by more animals that do not have the opportunity to be trapped elsewhere, while in the fragmented patches the opposite pattern is true - corner traps are the least likely to be encountered. The magnitude of this effect will increase for species with larger home range sizes. The data presented here tend to support this notion, as activity areas of *Peromyscus* are approximately twice as large as *Microtus* (Dooley, 1993). Thus some of the 'edge avoidance' seen in the fragmented landscape may be more of a methodological problem than a biological reality. However, radio telemetric data indicated that *Peromyscus* routinely moved the 50m distance from edge to edge in both the fragmented and unfragmented landscapes, suggesting that this problem may be minimal (Zawacki, personal observation). Unfortunately similar data were not collected for *Microtus*. Innate individual behavioral responses resulting from fragmentation have the potential to influence populations, and such issues need to be addressed in any evaluation of the effects of habitat fragmentation.

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Toxin Producing Phytoplankton in Chesapeake Bay

Harold G. Marshall, Department of Biological Sciences, Old Dominion University, Norfolk, Virginia 23529-0266

ABSTRACT

Three diatoms and nine dinoflagellates, known to be associated with toxin production, have been identified within Chesapeake Bay. Over the past several decades this number has increased to its present level so that they now represent approximately 1.7% the total number of phytoplankton species reported for the Bay.

INTRODUCTION

Hallegraeff (1993) and Smayda (1989) indicate there is a global increase in the occurrence and geographical distribution of marine phytoplankton blooms, including blooms produced by species that are toxin producers. Hallegraeff offers several reasons to explain the increased reports of bloom events. These are: 1) the scientific community is more alert regarding the presence of bloom producers and is now reporting blooms more frequently, 2) the greater use of coastal waters for aquaculture has provided additional favorable sites for blooms to develop, and represent additional sources for reporting toxic events, 3) there has occurred in recent years greater nutrient enrichment of coastal and estuarine waters that fosters increased phytoplankton abundance, including bloom events, and 4) the resting cysts of many algae can be transported in ballast water of ships that move from one global port to another, providing a mechanism for expanding the distribution range for species, including those that produce blooms.

For the past three decades the author has reported on the phytoplankton from Chesapeake Bay, plus many of the regional tributaries associated with this estuary, identifying 708 taxa from Chesapeake Bay (Marshall, 1994a). Since 1985, monthly phytoplankton collections have been taken at 7 stations within Chesapeake Bay. Reports based on the analysis of these collections have identified phytoplankton composition, productivity, plus spatial and temporal relationships to water quality variables and algal composition (Marshall, 1994a; Marshall and Alden 1990). The data obtained in this monitoring program, personal records, and other publications, have provided the information on toxin and bloom producing taxa used in this report. The purpose of this paper is to identify species in Chesapeake Bay that have been linked to toxin production in either field or laboratory studies.

Historical Records:

The earliest listing of phytoplankton taxa in Chesapeake Bay is by Wolfe et al. (1926), who reported on several seasonal collections within the Bay taken between 1916 and 1922. From these samples they noted 99 species. Subsequent systematic studies by Cowles (1930), Griffith (1961), Patten et al. (1963), Mulford (1967), and Marshall (1967) gradually added to the phytoplankton species identified in Chesapeake Bay. From these earlier papers the diatoms *Amphora coffeaeformis*, *Nitzschia* (*Pseudo-nitzschia*) f. *multiseries*, and the dinoflagellates *Cochlodinium heterolobatum*, *Dinophysis acuminata*, *D. acuta*, *D. caudata*, *Prorocentrum minimum*, have

since been recognized as potential toxin producers (Steidinger, 1993). Also noted by Morse (1947) and Mulford (1967) is *Gonyaulax catenella* Whedon-Kofoid (now classified as *Alexandrium catenella* (Whedon-Kofoid) Balech) and *Gonyaulax polyedra* Stein in the Patuxent River, and a single record of *G. polyedra* at the Chesapeake Bay entrance by Marshall (personal records). They both produce toxins, with *A. catenella* one of the causative agents for paralytic shellfish poisoning (Steidinger, 1993).

Phytoplankton Blooms:

The term phytoplankton bloom is generally applied to a rapid increase in abundance within the phytoplankton community. There are seasonal blooms where cell concentrations increase annually within entire bodies of water usually during spring, summer, or fall. In contrast, there are blooms that are more limited in their scope and composition. The term bloom used in this paper refers to a situation where over a relatively short period of time, there is a major increase in the cell concentrations of usually one primary species, with this growth more localized, and limited in its development and duration (e.g. days, few weeks). The water color during these events will typically have a red, brown, or green coloration, depending on the species producing the bloom, and its abundance. Cell concentrations of the primary bloom producer will vary with the taxon, and its cell size. Some of the large dinoflagellates will reach bloom concentrations at 10^5 cells l^{-1} , whereas with other taxa, bloom concentrations may level off at 10^6 to 10^8 cells l^{-1} . Blooms are commonly recognized as isolated surface patches of various sizes, or be concentrated along tidal fronts, appearing as streaks of discolored water.

Marshall (1989) reviewed the records of bloom events in the Chesapeake Bay from 1963 through 1989. The majority (67%) of these blooms occurred in tributaries to the Bay (near their river mouths), and 25% were located within the Bay, with the remaining (8%) in adjacent ponds and outside the Bay entrance. Blooms were recorded in each season, but the majority occurred during Summer (54%), followed by Fall (26%), Spring (15%), and Winter (5%). These blooms were not associated with toxin production, major fish kills, or shellfish poisoning, and may be produced by toxin or non-toxin producing species. Yet, there is wide variation in the ability of toxin producing species to produce toxins, and in the strength of toxins they produce (Hallegraff, 1993). The presence of a species reported to produce a toxin does not mean a potent toxin will be produced.

Dinoflagellates:

The following are dinoflagellates recorded since 1985 from Chesapeake Bay that have been associated with toxin production.

During mid-summer to early fall in 1992, a bloom of the dinoflagellate *Cochlodinium heterolobatum* Silva (= *Cochlodinium polykrikoides* Margalef) spread from the mouth of the York River into and out of the lower Chesapeake Bay, and was then transported in near shore waters southward to North Carolina. Concentrations reached 10^5 - 10^6 cells l^{-1} and at one time was spread over 215.7 km^2 of the central and western Chesapeake Bay (Marshall, 1994b). Prior to this event, blooms of this species were generally localized in the York River (Mackiernan, 1968; Zubkoff and Warinner, 1975; Zubkoff et al., 1979; Zubkoff, 1982). Since 1992, *Cochlodinium heterolobatum* has

apparently expanded its regional range, and has become established as an annual bloom producer in several rivers of the lower Chesapeake Bay, where previously it had not been reported (e.g. James, Elizabeth, Pagan, and LaFayette Rivers). The cells reproduce rapidly, often occurring in rows of 2, 4, or 8 connected cells. The blooms generally last several days and often extend into nearby inlets. This species is expected to produce summer blooms annually in the local rivers, and a more frequent appearance in the lower Chesapeake Bay is expected to occur. Although no major toxic events were associated with these blooms in Chesapeake Bay, Yuki and Yoshimatsu (1989) have linked this species with deaths in fish culturing grounds in Japan, and Steidinger (1993) lists this dinoflagellate as a toxin producer. This species will reach bloom concentrations at river sites generally in late July with major development typically occurring in August. It is often accompanied by several non-toxin producing dinoflagellates in lesser abundance, including *Scrippsiella trochoidea* and *Gymnodinium splendens*, along with cryptomonads and several diatom taxa.

Prorocentrum minimum (Pavillard) Schiller is well documented in the early reports of Bay phytoplankton, in addition to an account of a small *Prorocentrum* mentioned by Cowles (1930), that was probably *P. minimum*. *Prorocentrum minimum* is reported to produce a toxic substance directly responsible for fish and shellfish kills (Okaichi and Imatomi, 1979; Steidinger, 1993). Tyler and Seliger (1978) have associated this species with seasonal blooms in the upper Chesapeake Bay and its transport to these sites within sub-pycnocline waters. In the lower Bay this species is generally ubiquitous, and increases in abundance in spring, reaching higher levels in summer and fall. It is also a frequent sub-dominant species during bloom events and is one of the most common dinoflagellates in the Bay (Marshall, 1994a).

The genus *Dinophysis* is represented in the Chesapeake Bay by five species that are known to produce okadaic acid, or other toxins causing diarrhetic shellfish poisoning (Yasumoto, 1990; Steidinger, 1993). These substances when concentrated in clams, oysters, etc. may cause this illness in humans who eat the infected shellfish. These include *Dinophysis acuminata* Claparède and Lachmann, *D. acuta* Eherenberg, *D. caudata* Saville-Kent, *D. fortii* Pavillard, and *D. norvegica* Claparède and Lachmann. These species are present within Atlantic coastal waters and their cells may be found frequently in sub-pycnocline waters entering Chesapeake Bay. Major outbreaks of diarrhetic shellfish poisoning have occurred in European waters due to *D. acuminata* and off Nova Scotia by *D. norvegica* (Kat, 1985; Rao et al., 1993). Although not abundant, and often rarely noted, each of these *Dinophysis* spp. have been recorded in the lower Chesapeake Bay. In addition, *Dinophysis tripos* Gourret, reported by Yasumoto (1990) as a toxin producer, has also been identified from shelf waters in the vicinity of the Chesapeake Bay entrance (Marshall, 1982).

Gyrodinium aureolum Hulburt has a broad geographic distribution and is known as a toxin producing bloom species that has been associated with massive fish and invertebrate mortality (Tangen, 1977; Jones et al., 1982). This species was first reported in Chesapeake Bay by Marshall (1980a), but was not noted again till over a decade later in an isolated inlet at the U.S. Naval Amphibious Base in Virginia Beach (Marshall, 1994b). Its presence there was possibly due to ballast water discharged in the harbor.

The most recent event regarding a potent toxin producing dinoflagellate was the discovery of *Pfiesteria piscicida* Steidinger and Burkholder from Jenkins Creek in the

upper Chesapeake Bay (Lewitus et al., 1995). It is a polymorphic species, possessing flagellated, amoeboid, and cyst life stages, with the cysts in the substrate activated into motile cells by the presence of fish (e.g. by their excreta) (Burkholder et al., 1992). These cells attach to the fish and produce the toxin that will poison them, and then return to the substrate and form cysts. This species has produced extensive fish kills in North Carolina estuaries with its toxin producing various neurosensory ailments in humans (Burkholder et al., 1995; Franklin, 1995).

Although mentioned above in the earlier literature, the following species were not found in the present monitoring program (1985-1996): *Alexandrium (Gonyaulax) catenella* (Whedon-Kofoid) Balech and *Gonyaulax polyedra* Stein. Marshall (1982) has also reported *Gymnodinium breve* Davis, the agent causing neurotoxic shellfish poisoning, off the Chesapeake Bay entrance, but this species has not been noted since for this area. This is primarily a tropical and sub-tropical species that is not expected to be common in these waters.

Diatoms:

To date, four diatoms that are recognized as domoic acid producers, have been recorded for Chesapeake Bay. These are *Pseudo-nitzschia multiseries* (Hasle) Hasle, *P. pseudodelicatissima* (Hasle) Hasle, *P. seriata* (Cleve) Peragallo, and *Amphora coffeaeformis* (C. Agardh) Kützinger.

Amphora coffeaeformis is a pennate diatom rarely reported in the Bay, but has been found in the barrier islands of Virginia (Marshall, 1980b). This species is not considered a major bloom threat, although it has been associated with domoic acid production.

Over 30 years ago Hasle (1965) first identified the diatom *Nitzschia pungens* f. *multiseries* Hasle from water samples that included those taken in lower Chesapeake Bay. This is a small pennate diatom, found usually in colonial chain-like filaments of 3 to 4 cells in length. It is so similar to the ubiquitous *Nitzschia (Pseudo-nitzschia) pungens* Grunow that it would be very difficult to distinguish the difference between these two species with light microscopy. In fact, it has not been reported in Chesapeake Bay since Hasle (1965). *Nitzschia pungens* f. *multiseries* gained international attention in 1987 when a food poisoning event in Canada was traced to cultured blue mussels (*Mytilus edulis*) containing high concentrations of domoic acid produced by this diatom (Bates et al., 1989). Domoic acid is the agent that is transmitted to shellfish by these diatoms, which causes amnesic shellfish poisoning in humans. *N. pungens* f. *multiseries* and related species, have recently been reclassified (Hasle, 1995) into another genus and is now identified as *Pseudo-nitzschia multiseries* (Hasle) Hasle. In examining current phytoplankton samples with electron microscopy, Marshall (1994a) did not find *Pseudo-nitzschia multiseries*, but reported an abundance of *Pseudo-nitzschia pseudodelicatissima*, noted for the first time in Chesapeake Bay, and this species is another domoic acid producer (Martin et al., 1990).

Pseudo-nitzschia pseudodelicatissima (Hasle) Hasle, *P. seriata* (Cleve) Peragallo, and the non-toxin producer *P. pungens* are common members of this genus in lower Chesapeake Bay. Past records of these species have probably included *P. pseudodelicatissima* with *P. pungens*. Annual mean abundance for *P. seriata* and *P. pungens* (combined with *P. pseudodelicatissima*) over a 10 year period are 3.3×10^4 and 9.9×10^4 cells l^{-1} respectively. Of the three, both *P. pungens* and *P. pseudodelicatissima* appear to be increasing in abundance and *P. pseudodelicatissima* has become estab-

lished over the past decade in Chesapeake Bay. *Pseudo-nitzschia multiseries* (Hasle) Hasle may still be existing somewhere in the Bay, but is not abundant compared to these other members of the genus at this time. There are no records to date of any of these species producing toxic blooms in Chesapeake Bay. It is feasible that the absence of toxin production by these species is because these are local strains that do not produce high levels of domoic acid, or the appropriate environmental conditions that may initiate this bio-product have not been present.

Non-toxic bloom producers:

The Bay also contains numerous non-toxin producers within its phytoplankton that have seasonal blooms which on occasion have resulted in reduced oxygen levels within the water column, and could negatively impact the fauna. The dinoflagellate species seasonally include: Early spring *Heterocapsa triquetra*, *Katodinium rotundatum*, Summer: *Ceratium furca*, *Prorocentrum minimum*, *Scrippsiella trochoidea*, *Gymnodinium splendens*, Fall: *Noctiluca scintillans*, *Prorocentrum minimum* and others. Most prominent with these dinoflagellates, would be seasonal developmental peaks (spring, summer, fall) of the diatoms *Skeletonema costatum* and *Cyclotella choctawhatcheeana*, *Rhizosolenia fragilaria*, *Asterionella glacialis*, *Leptocylindrus minimus*, etc., in addition to the ubiquitous cryptomonads and autotrophic picoplankton. The various species (mostly cyanobacteria) in the autotrophic picoplankton become very abundant during summer. Their summer concentrations may reach 10^9 cells l^{-1} with a basic abundance level during other seasons between 10^5 - 10^6 cells l^{-1} (Marshall, 1995). The settling of high concentrations of any of these bloom cells and other summer components within the water column and to the bottom substrate is a contributing factor to summer hypoxia conditions that occur in the deep basins within the Chesapeake Bay. The relationships of many of these seasonal blooms to nutrients, total suspended solids, light availability, etc., within the Chesapeake Bay have been discussed by Fisher et al. (1988), Harding et al. (1986), Marshall and Alden (1993), and others. In addition to these algae, the ciliated protozoan *Mesodermium rubrum*, which contains a red cryptophycean as an endosymbiont, also produces extensive blooms in the Bay. For instance, in October 1995, cell concentrations during a bloom covered a large extent of the lower Chesapeake and reached concentrations of 5.1×10^5 cells l^{-1} .

DISCUSSION

The Chesapeake Bay estuary does not presently have a historical record of major phytoplankton toxic induced events. However, there are 3 diatoms and 9 dinoflagellates known to produce toxins that have been reported within the last decade in Chesapeake Bay (Table 1). Historically, 2 additional dinoflagellates and 1 diatom known to be toxin producers have been reported in earlier literature from within Chesapeake Bay, for a total of 15 toxin class species of record. With a total of 708 phytoplankters identified in the Bay (Marshall, 1994), the 12 species represent 1.7% of the present population, or if the earlier 3 species are included 2.1% of the total taxa, as toxin producers. Sournia et al. (1991) report there are globally approximately 4400 marine phytoplankton species, with 50 to 60 of these (1.1 - 1.3%) described as toxin producers (Steidinger, 1993). The presence of these potential toxin producers in Chesapeake Bay is slightly greater than the global relationship noted above. However, due to the more

TABLE 1. Phytoplankton recorded within the Chesapeake Bay system that have been reported in the literature to be toxin producers.

A. Recorded between 1985 and 1996.	
I. Diatoms:	<i>Amphora coffeaeformis</i> (C. Agardh) Kützing <i>Pseudo-nitzschia pseudodelicatissima</i> (Hasle) Hasle <i>Pseudo-nitzschia seriata</i> (Cleve) Peragallo
II. Dinoflagellates:	<i>Cochlodinium heterolobatum</i> Silva <i>Dinophysis acuminata</i> Claparède and Lachmann <i>Dinophysis acuta</i> Ehrenberg <i>Dinophysis caudata</i> Saville-Kent <i>Dinophysis fortii</i> Pavillard <i>Dinophysis norvegica</i> Claparède and Lachmann <i>Gyrodinium aureolum</i> Hulburt <i>Pfiesteria piscicida</i> Steidinger and Burkholder <i>Prorocentrum minimum</i> Pavillard and Schiller
B. Recorded prior to 1985	
I. Diatoms:	<i>Pseudo-nitzschia multiseriata</i> (Hasle) Hasle
II. Dinoflagellates:	<i>Alexandrium catenella</i> (Whedon-Kofoed) Balech <i>Gonyaulax polyedra</i> Stein

favorable conditions for growth, a larger number of toxin producers would be expected within estuaries such as Chesapeake Bay than in global seas. This level of representation in Chesapeake Bay, may be expected within other comparable estuaries.

Although there is an apparent absence of toxin related events at this time in the Chesapeake Bay, the potential for these to occur exists from species already present in this ecosystem, in addition to new species that may be introduced. There is also evidence that concentrations of potential toxin producers now living in the Bay are increasing. Several *Dinophysis* spp. and *Pseudo-nitzschia pseudodelicatissima*, which represent potential sources for outbreaks of diarrhetic and amnesic shellfish poisoning respectively, are gradually becoming more common in Bay. The rapid increase in the range and frequency of blooms by other species, such as *Cochlodinium heterolobatum*, indicates species once more limited in their range of development, can over a short time period become a dominant component within the phytoplankton community. It is species of this type, gaining a more dominant role within the ecosystem, that may have more significant long term impact on the water quality and trophic relationships in these waters. Their success may be due to increased anthropogenic factors (e.g. nutrient enrichment within the watershed), or changing environmental parameters that favor their development. These conditions may also enhance the development of newly observed and dangerous species such as *Pfiesteria piscicida*, which has the potential for expanding its distribution within the estuary. New phytoplankton taxa are certainly

expected to be recognized for the Chesapeake Bay, and among these other toxin producing species are also likely to be found.

The enigma regarding many phytoplankton species is that not all of the potential toxin producers will produce toxins, or blooms in their respective habitats. For instance, high concentrations of a particular dinoflagellate may be a toxin producer and contaminate shellfish in an estuary or entire coastal region, but the same morphological species at another site may not produce toxins. This difference may be due to some environmental factor, or more likely a combination of particular environmental conditions, that alter a physiological response in these cells to produce, or not produce a particular bio-product (e.g. a toxic substance). Another explanation is that there are numerous species, that contain within their populations, physiological deviants from the norm (physiological species, or different strains of a species), with or without the capability of producing toxins. Such differences within these populations would not be considered unusual, since the incidents of mutational events that may impact their genetic make-up and cell metabolism would be expected to occur.

ACKNOWLEDGEMENTS

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Minutes of the Executive Committee Virginia Academy of Science

Nov 5, 1995, Room 187 Ruffner Hall, University of Virginia, Charlottesville
Present: Thomas O. Sitz (President), Elsa Q. Falls (Immediate Past President), R. Dean Decker (President-elect), Carolyn M. Conway (Vice President), Joseph W. Rudmin (Secretary), Greg Cook (Treasurer), Donald R. Cottingham (Director, Junior Academy of Science), James H. Martin (Editor, the Virginia Journal of Science), Lisa L. Martin (Administrative Assistant, VAS-VJAS).

The meeting commenced at 10:12 am.

1. There were no introductions.
2. Adoption of the agenda was moved by T. Sitz, and was seconded and approved.
3. The minutes of the May 24 and May 25 Executive Committee meetings and the May 25 Academy Conference were corrected and approved.
4. Officers' Reports
 - a. President's Report

Tom Sitz recounted the Executive Committee's actions during the summer concerning the Science Museum of Virginia. Three letters were distributed. For more detail on this, the reader is referred to the minutes of the Nov 5 1995 Council meeting.

Tom Sitz asked Dean Decker to report on the Ad Hoc Committee to Study Academy Needs with Regard to Fund Raising which he did as follows. The Committee consisted of Dean Decker, Carolyn Conway, Art Burke, Richard Brandt, and Jim O'Brien. The Committee defined the terms "endowment/endowed", "named endowment", "Virginia Academy of Science", and "Virginia Junior Academy of Science". The Committee then made recommendations that the following categories of funds be established: Expansion and continuation of the awards program of the VJAS, support to establish a paid director of the VJAS, support for the education and research activities of the VAS, and a discretionary fund for the VAS/VJAS management. Since anticipated returns are greater than 5%, this amount should be guaranteed to the Academy for use, with the rest returned to increase the principle. The Committee recommended that new named endowments must be started with \$5000 or more, new unnamed endowments must be started with \$3000 or more, and new donor-designated funds must be started with \$1000 or more. For more detail on this, the reader is referred to the minutes of the Nov 5, 1995 Council Meeting. These are the recommendations from the Ad Hoc Committee to the Fund-raising Committee.

Tom Sitz during the summer had appointed an ad hoc committee to review the VJAS secretarial position. This committee consisted of Dean Decker, Art Burke, and Elsa Falls. They submitted a list of Recommendations to the Executive Committee which were now discussed, starting with the budget. Elsa Falls presented the recommendations. It was noted that the Research Committee had not used its full \$10000 budget, and accordingly recommended that it revert to the previous year's \$8000 to free money for other uses.

EXECUTIVE COMMITTEE ACTION:

The motion was made, seconded, and passed, to recommend to the Council the reduction of the Research Committee's budget from \$10000 to \$8000.

Discussion of the budget continued. Since part of this discussion dealt with the administrative assistant's salary, Lisa Martin left the room at this time. The ad hoc committee to review the VJAS Associate Director Position made the following recommendations to be acted upon by the Executive Committee:

I. As a stop-gap measure: That the secretary begin to maintain regular hours on a daily basis (Mon-Fri) from September through December 1995 at the VAS office, and that her salary be increased \$125 per month for each of those four months, to compensate for the increased demands on her time. (This is a stop-gap measure until the recommendations which follow can be acted upon by the Executive Committee at its November Meeting. The above Recommendation was approved by members of the Executive Committee when contacted by phone on Sept., 11, and Blanton Bruner has implemented the recommendation.)

II. As soon as possible: That Jim Martin be asked to explore the purchase of an additional computer and printer by VAS to be kept at the Martin residence for the use of both Jim and Lisa. The new machine and software should be compatible with the current machine owned by VAS, which is to be housed at VAS office. (It is suggested that this purchase be expedited, so that the new equipment will be available as soon as possible.)

III. Effective January 1, 1996:

1. That the VAS office be staffed six hours a day (from 10 a.m. to 4 p.m.) and five days a week from Labor Day to Memorial Day. Hours would be more limited from Memorial Day to Labor Day. Lisa Martin would be present from 12-4 p.m., and Blanton Bruner and Art Burke would divide the morning hours from 10-12 noon.

2. That Blanton Bruner (at his request) begin to curtail his responsibilities as Executive Secretary-Treasurer. His yearly salary would be decreased by one-half for 1996.

3. That Art Burke be appointed as Associate Executive Secretary-Treasurer and begin to assume more of Blanton Bruner's duties. There would be no remuneration for his services (at his request.)

4. That the position of administrative assistant (job description attached) be designated as three-fourths of full-time. Following this was an itemized description of the the purpose, duties, annual review, and tenure of the position.

The Executive Committee now discussed and acted upon these recommendations.

First item 3 above was discussed. Joe Rudmin asked if the creation of the position of Associate Executive Secretary-Treasurer would require a change in the Constitution. The consensus of the Executive Committee was that a change would be required. Since the position of Associate was viewed as temporary anyway, the Executive Committee decided not to act on item 3 above, but to leave the title as it now is. Next the committee discussed item 1 above, and the associated required salary increase. Elsa Falls noted that part of the increased cost was covered by Art Burke's rejection of his salary. Several Committee members expressed their support for the salary increase. Joe Rudmin asked if there were any increased expenses

associated with raising her salary, e. g. Social Security. Elsa Falls replied that the contract management agency covers that expense, and their charges to us don't increase. Joe Rudmin and Elsa Falls noted that the report of the Finance and Endowment Committee predicts a budget deficit of \$11,140 in the coming year, compared to a surplus of \$5370 last year. Elsa Falls also noted that a check to the Academy from the Local Arrangements Committee for the VMI meeting of \$34,445 was not shown in the report. This includes both profit from the meeting, and some funds from membership dues. Her understanding was that there was also a profit from the JMU meeting, which is put into some fund which Rae Carpenter is managing. Elsa Falls said that including these profits, the deficit shown is simply on paper. Don Cottingham(?) confirmed that the profits from the JMU meeting were \$5000 more than had been budgeted. Elsa Falls said that given this financial report, the Academy should be able to handle the expenses of the recommendations given under Roman numeral III above.

EXECUTIVE COMMITTEE ACTION:

The motion was made, seconded, and approved, to increase the salary of the office secretary from \$2830 to \$13640 associated with her increased duties, as recommended by the Ad Hoc Committee. Tom Sitz then introduced a new item. Jim O'Brien requested some money from him to buy some commercial and industrial directories useful for fund-raising and asked if the Council had ever approved some kind of a budget for the fund-raising committee? Elsa Falls said that there was a \$2500 budget for the Legacy 75 campaign, which was a little less than Jim had asked for. Tom commented that in that case he should be able to use those funds at his discretion.

The next item was the discussion of the purchase of the computer. The cost of the computer is shown in the 1996 budget, but in fact it was paid for from unused funds of the 1995 budget, and is now installed and operating. Joe Rudmin suggested that the computer could gain access to the e-mail services of internet at a modest cost from a long-distance carrier, saving money on stamps. Joe Rudmin also suggested that perhaps the VAS could get a computer account at one of the Richmond colleges, thus gaining full internet access.

Next the Executive Committee discussed the job description of the administrative assistant. The Committee decided to leave the duties flexible, but to formally institute Annual Review and Tenure provisions, as written in the recommendations, and as reproduced below.

ANNUAL REVIEW

The job description and performance of the Administrative Assistant shall be reviewed on an annual basis by a committee appointed by the VAS President; the committee should include the Executive Secretary-Treasurer and the VJAS Director. The results are to be reported to the VAS Executive Committee before its fall meeting for appropriate action.

TENURE

The appointment of the Administrative Assistant is renewable on January 1 of each year. Should either VAS or the Administrative Assistant desire to terminate this relationship, a notice of at least two calendar months is appropriate.

EXECUTIVE COMMITTEE ACTION:

The motion was made, seconded, and approved to accept the above recommendations of Annual Review and Tenure for the Administrative Assistant.

EXECUTIVE COMMITTEE ACTION:

The motion was made, seconded, and approved, to accept the budget as modified by the Executive Committee.

b. President-Elect, Dean Decker

Dean Decker gave corrections to his phone number, fax number, and e-mail address. This prompted numerous other corrections by other members of the executive committee. Joe Rudmin noted that correcting the addresses in the Directory is awkward, since each Committee-member entry also contains an address. He suggested that the address should appear only in the membership entry, and that committee entries should contain only the name. Carolyn Conway commented that not every committee member is a member of the Academy. The discussion continued briefly with Dean Decker favoring having address at the first appearance of the name, and Tom Sitz favoring putting addresses in the membership listing. Joe Rudmin pointed out that having special categories of membership, such as life members and sustaining members, complicates the directory. He said that there should BE a directory. In the list, put a dagger or letter by the names to tell categories of membership.

Dean Decker: I received a letter from Mr. George Dewey of the Virginia First Joint Congress for the Teaching of Math and Science. The organizations which belong to that are the Virginia Association of Science Teachers, the Virginia Council of the Teachers of Mathematics, the School of Science and Mathematics, the Virginia Quality Education of Science and Technology, The Virginia Council for Mathematics Supervision, and the Virginia Science Leadership Association. I'm just curious how this kind of an organization is coming together without the Academy being any part of it.

Don Cottingham: It's not an organization, Dean. It's a combination.

Joe Rudmin: Is VAST one of those things? The Virginia Association of Science Teachers? Don't they meet next week?

Don Cottingham: Thursday, Friday, and Saturday. We are exhibiting and presenting there. I'll be representing both the VJAS and the VAS.

Dean Decker: I was curious that a conference of this type was called and the Academy was not considered part of it.

Don Cottingham: That was probably my fault. I am on the VAST board. Unfortunately, I don't think of the VAS as a teaching organization. Perhaps I should.

Dean Decker: Well we have a teaching section, and virtually every member of the Academy is in the classroom.

Joe Rudmin: Nevertheless, we are more than a teacher's organization.

Dean Decker: I agree, but that doesn't mean we shouldn't be participating in something of this type.

Joe Rudmin: Don, why don't you just represent us at the meeting.

Don Cottingham: I am the VAS representative on the VAST board, but VAST has never sent a representative to our board. Similarly, we have a representative on the VSLA board, but they have never sent a representative to our board.

Dean Decker: One thing which should be brought before the Executive Council. I am the editor of the newsletter for the National Association of the Academies of Science, and one of the other Academies suggested that there be an exchange of newsletters among the state academies. I intend to do this and am informing you. We should put on our newsletter mailing list, those state academies which want to be on it. Our Newsletter has been pretty inactive, and it's gotten a lot more active recently. Other academies want to know what we're doing, and what our activities are, and it seems like the Newsletter is a way to do it.

Joe Rudmin: Twenty or thirty newsletters might be a bit much to archive. Might it not be better just to maintain a listing of where each newsletter is archived, so that we would know where to write if we say, wanted to find out what was happening in Ohio.

Dean Decker: Several academies have written me and asked if we couldn't get an exchange of newsletters going, so I intended to put into the newsletter which I'll write next week, that I'll be the clearing house and put them in touch with each other, and then let them work out how they want to exchange newsletters. If they want to exchange hardcopies all the time, or do it by e-mail, that's up to them. Right now they want to know how to get in touch with each other. Not all state academies are members of the National Association of Academies of Science.

Greg Cook: As a first step, I'll contact their web site and find out what academies are listed there, and send their email addresses to Jim and Lisa.

Dean Decker: That's all I have to report.

c. Vice President, Carolyn Conway

I want to tell you of a couple of things that are in the works. I'm using my authority to make the following change. In the past, abstracts were sent in to the section secretaries in April. A lot of people, including me, failed to send them in before the meeting. The abstracts don't always get to Jim Martin. So from now on the abstracts will be handed in at the meeting, and this will reduce the number of hand-changes, and having to send them through the mail. In polling the section secretaries, to find out how many actually made copies of the abstracts to pass out at the meeting, I found that the only section which does this is the medical sciences section. So I authorized them to collect their abstracts ahead of time, and then make sure that they get to the right person. We are making it clear that the abstracts are to be handed in at the time of presentation.

I'm also trying to clarify that statement that every presenter must be a member of the Academy. It now reads that while titles will be accepted by non-members, presenters **MUST** join prior to the meeting. We will contact non-member presenters before the meeting and try to get them to join the Academy.

Elsa Falls: This needs to be done. I know that in each of the last two years, we have had at least seventy presenters who were not members.

Carolyn Conway: I will take on that responsibility. And a somewhat unrelated item, Tom Haas, Chair of the Local Arrangements Committee, asked me for registration forms. I had some left over from the VMI meeting. I also included a note to him to eliminate the item on the registration form which allows them to pay

their dues and register at the same time, because at the VMI meeting, we got one check which included both registration and fees, and we had no way of separating them. We can separate these payments and have the dues go right to the academy with outgoing through the local arrangements committee first.

Joe Rudmin: Again, this would be much more easily handled if somewhere there were a single list of the current membership. If the defining list were on a computer, it would be easily searchable. Another thought is that we can effectively say that the paper was not given, if the dues were not paid. We would not publish the title or the abstract, if the dues were not paid.

Carolyn Conway: We can't not publish the title, because that has to be done in advance. We need to get out reminders to people, whether they're students or just some of us who have neglected to pay. Unlike some other organizations, where you don't need to be a member to present, we don't have dues or registration fees costing one or two hundred dollars. Our registration fee plus the membership fee is pretty minimal. I'll take care of this. It won't be the responsibility of any section officer to do it. When we send out the forms for the abstracts, we can include a letter, saying "We note that you have not joined the Academy. Please send your money in right now." We know there will be problems, but perhaps we can cut the number down from seventy five to twenty five.

d. Secretary, Joseph W. Rudmin: No report

e. Treasurer, Greg Cook: No report

f. Immediate Past President, Elsa Falls

Elsa Falls: I note in the report of the Finance and Endowment Committee, that they recommend that the dues be increased by one dollar to be credited to the Legacy 75 campaign.

Tom Sitz: I was going to bring that up. That creates all kinds of problems. The Bylaws would have to be changed, and forms changed. The recommendation is to Council, so we can defer until that time.

Carolyn Conway: We could do like many other organizations do, and include a separate sheet of paper asking for an additional contribution.

Elsa Falls: Another thing I want to be sure is in the minutes is an update on what happened with the Resolution passed by the Council and the Academy Conference on the importance of laboratory in Science Education. As far as I know, that resolution did go to every college and university in the state, and to every appropriate person in state government. I also did call Beverly Orndorff, who is the science editor of the Richmond Times Dispatch, who did write an article. It was great that we got that published. And we even got a letter to the editor of the Dispatch. Of the hundred or so letters we sent out, I only got one response, and that was from Gordon Davies, the Director of the State Council for Higher Education. He said "Thank you for the letter on the importance of laboratory science. We agree with you that our students have great experiences in their science courses."

Joe Rudmin: That is not very supportive.

Elsa Falls: Well at least he responded. No one else even did that.

Dean Decker: In addition to that, I enclosed it in the newsletter to the National Association of Academies. I got a letter from a high school teacher in California saying that she wasn't aware that that was what was going on in colleges. I said

"Hang on, it's coming your way." At the National Association of Biology Teachers last week I got a comment about that. It's not limited to Virginia by any means. That served to alert a lot of them, and I got one letter requesting permission to use it. I said "Go ahead."

Elsa Falls: Jim did put it in the Journal. Was it in the Scientist?

Greg Cook: Well, I will be putting it in the next issue.

g. Virginia Junior Academy of Science Director, Don Cottingham

The Local Arrangements Committee for the VCU meeting met. Everything is going fine. We have good facilities, and it will be a compact meeting. The committee met last summer and decided to try allowing computers to be used in the presentations in the Computer Science section. The speakers will furnish their own computers and be responsible for them. We will put a disclaimer in the notice that the VAS and the VJAS will not be responsible for them. We've already written the statement and would like to get some feedback of its legality.

Tom Sitz: We're checking into it.

Don Cottingham: Also, we're reducing the judges in each section to two, with the section chair serving as tiebreaker in awarding prizes. We also voted to delay regionalization until next year. We were all set to go this year. We had a date and a time at Virginia Western Community College but a lot of people raised the question, why should they have to go through a regional judging when people in the rest of the state can go straight to the state conference. Also, we do not have a Regional Director yet, and until we do I think it would be very foolish to continue our regionalization efforts. I don't think I can do it. So that's where we stand on regionalization right now. I've contacted all the Community College presidents in that region, and they've all said that other things are more important, with the budget cuts and all. We've also revised our readers and judges forms in the computer section to be more in line with presentation practice. As I already said, I will be carrying the VAS exhibit to Williamsburg on Thursday. This year so far, I've received more requests for information about VJAS from new people who are interested in joining than in previous years. Virginia Beach for the first time has had their Science Supervisor contact us, and it looks like they may come in. Last but not least, I would like to ask each of you to start thinking about my replacement in 1997.

Greg Cook: I think we all have to recognize the tremendous amount of work that goes into that. We should begin our search as soon as possible and try to have somebody in place by the annual meeting this coming year. We shouldn't wait until the last minute.

Carolyn Conway: We have a committee to try to find someone to take over this job, and they would welcome any suggestions. Jerry Taylor asked last year to be taken off, and that leaves me. I don't know anyone. People that I've thought of are all young folks that while they have an interest, they've got to have a salaried position, so it's going to be hard.

Don Cottingham: Well I have a person in mind, who might be a good person.

Carolyn Conway: Please pass that along.

Dean Decker: A year ago, Jerry came to me, and we talked about two or three possibilities, and they were asked, and they all turned it down.

Don Cottingham: Did you approach Mary Francis? She's one I think would be ideal, and I think her sons are in college now. The only problem is she's still teaching, and for an active high school teacher it would be very very difficult.

Dean Decker: Yes, but high school teachers control the American Junior Academy, and it's worked out fine.

5. Executive Secretary-Treasurer, Blanton Bruner (with Arthur Burke, Jr.)

Lisa Martin: Blanton says to tell you he's sorry he couldn't be here and he sends you his regards, and he asks that I pass this along to you about the businesses and the standing invitations to colleges. In past years, we have had someone write a letter, thanking the business members for their support and asking that they continue their support, and emphasizing the importance of that support. Susan Hutchinson at Philip Morris is the one who has written that letter, isn't that right, Dean?

Dean Decker: I think so.

Elsa Falls: And that letter has not been sent for a couple of years before Philip Morris withdrew their support for the juniors, although they are still members of the Academy, and they do pay their dues. The letter has not been sent out in several years now, and we would like to have you all think of someone who has a name that might be recognized around the state, someone who would be able to write this letter to these institutions. And we usually send it to the governor, but we can't get his support either. We usually send that letter out with the invoice, which is supposed to be going out now. And I do have a list of colleges, Norfolk State, Virginia State, Bridgewater, that have not paid dues for the past year, maybe not even 94, and a few of the businesses we'd like to keep. We can hold out and not mail those right now.

Dean Decker: Several names come to mind. One is the President of the Academy, and one from the Richmond area in industry, Preston Leak is one.

Don Cottingham: If you want somebody from industry to do it, it might be Eva Teague (?) at Virginia Power. I don't know if that's a dirty word or not around the state. But I've met her on several occasions, and I know she's very receptive and came through on interest and awards, and I think if we contact Lynn Wilson and maybe even presented them with a letter that we'd like to have signed, or asked them to write a letter, I think Eva probably would sign it and I think she's vice president.

Joe Rudmin: I have to differ with you on something here. I'd like to point out that in January of this year, a committee of Ronald Carrier's vice presidents fired the entire physics department. As a result of that he received a vote of no confidence from the faculty. For the Academy to invite him to send a letter would be very controversial on the JMU campus. I think this year it would be better to have some other university president write that letter. Things are not yet finished there.

Dean Decker: Trani at VCU has been very supportive in terms of having us there again shortly.

Carolyn Conway: He wasn't there before.

Dean Decker: He wasn't? So we don't know. I guess the Virginia Tech President wasn't there either.

Tom Sitz: No, he wasn't.

Carolyn Conway: I think Eva Teague is a good choice. I think she would probably do it.

Elsa Falls: Also she's from business. I don't think it's good to have too much academic image.

Don Cottingham: She's from a business and they certainly have supported us in the past. She's speaking from a position of having done it. Lynn Wilson is the person to contact. I have her telephone number, and Lynn is a very easy person to talk to.

Tom Sitz: In the meantime, I'll get a letter out.

Lisa Martin: Well the invoices are not ready, and they have to be printed and the envelopes stuffed, so it will be at least a week.

Joe Rudmin: Related to this, I'd like to make the following suggestion. I think the Academy would be greatly strengthened if there were an industrial representative on this committee, somebody whose job would be to round up support every year, to carry on activities between us and industry, to help with fund raising, scholarships, and work with the secretary and the Director of the Junior Academy, who would work hard at it for two years, and pass the job onto somebody else. Someone who would keep the industrial membership up, I think it would greatly strengthen the Academy. I'd like to see a position on the Executive Committee. It would require a change in the constitution.

6. Local Arrangements Committee Reports (No reports)

a. 1995 VMI, D. Rae Carpenter and R. B. Minnix

b. 1996 VCU, Tom Haas

c. 1997, Virginia Tech, John Hess and Tom Sitz

7. Old Business: None.

8. New Business:

Greg Cook: There are two things I'd like to mention. One is that it's been no secret that I've had difficulty getting the Virginia Scientist out, and I would like for us to begin looking for a replacement. For a number of reasons it's very difficult for me to do this now. Jim O'Brien and I got the newsletter started four or five years ago now, and it's time to pass it on. Along these lines, I'd like to ask that the position of editor be a finite position. If we made it a three or four year position it might prevent people from getting in the awkward position that I'm in now. I find a need to quit doing it, but I don't want to just put it down and walk away.

Elsa Falls: This should be addressed by the publications committee. You and Jim are the co-chairs, and can vacate those positions in 1996.

Greg Cook: Then Jim and I can step down gracefully.

Elsa Falls: I don't know about gracefully, but there is the opportunity to step down every three years.

Tom Sitz: Do you have anybody in mind to step into your shoes?

Greg Cook: Well, Jim and I have some ideas, but please think of people in your institutions who might serve. The second thing I want to say, on the good side, is that I can offer the academy a web site at no cost to the Academy, and I am heavily involved in that type of debris at this point in my life. I think this is something that would benefit the Academy. We're talking about publications in general entering a new age, where print is no longer the only way to get information out. I can begin doing it this fall informally.

Following this was a brief discussion concerning emeritus membership, and a mention by Carolyn Conway of a new e-mail address.

Joe Rudmin: Can I request that the question of an industrial representative be placed on the agenda for the next meeting? It's the kind of thing people should think about and not have to vote on suddenly.

Tom Sitz: Bring this up in Council. There's a wider representation of people there. It sounds like a win-win type of thing.

There were no concluding remarks, and the meeting adjourned at 12:15.

10. Adjournment

The Meeting adjourned at 9:20 am.

VIRGINIA ACADEMY OF SCIENCE COUNCIL MEETING MINUTES

Nov 5, 1995, Room 187 Ruffner Hall, University of Virginia, Charlottesville

Present: Thomas O. Sitz (President), Carolyn M. Conway (Vice President, Biology, Awards Committee), Joseph W. Rudmin (Secretary, Membership Committee), Greg Cook (Treasurer, Publications Committee, Virginia Scientist Editor), R. Dean Decker (President-elect, Science Education Committee), Elsa Q. Falls (First Past President), James P. O'Brien (Second Past President, Fund Raising Committee), Golde I. Holtzmann (Third Past President, Archives Committee, 75th Anniversary Committee, Nominations and Elections Committee), Eugene B. Barfield (Archaeology, Public Affairs Committee), Gerald R. Taylor (Constitution and Bylaws Committee; Astro. Math, and Physics), Michael L. Bass (Constitution and Bylaws Committee, Environmental Science, Committee on the Environment), Vera B. Remsburg (Science Museum of Virginia Trustee), Marion Lobstein (Virginia Flora Committee, Botany), Pamela Turpin (Education), Sandra P. Welch (Medical Sciences), Robert A. Berquest (Psychology), Donald P. Cottingham (Junior Academy of Science Committee, VJAS Director), Richard B. Brandt (Long Range Planning, Gwathmey and Jeffress Trusts Rep.), James H. Martin (Publications Committee, Va. Journal of Science Editor), D. Rae Carpenter, Jr. (Trust Committee), Ertle Thompson (AAAS/NAAS Rep.) Lisa Martin (Administrative Assistant to the Executive Secretary-Treasurer)

Absent: Fred H. Lutze (Aeronautical and Aerospace Science), Scott H. Newton (Agriculture, Forestry, and Aquaculture), Eleni Achilleos and Penny Pagona, (Biomedical and General Engineering), George W. Mushrush (Chemistry), Robert A. Willis (Computer Science), Steven Wright (Geography), David Walz (Geology), Kenneth Lawless (Materials Science), Judy H. Niehaus (Research Committee), Francis Macrina, (Microbiology and Molecular Biology), Michael Kosztarab (Natural History and Biodiversity), Arthur W. Burke, Jr. (Finance and Endowment Committee, Ass't Exec. Sec-Treas), Paul J. Homsher (Finance and Endowment Committee), John P. Morgan (Statistics), William L. Dewey (Science Advisory Committee), William L. Dewey (Science Advisory Committee), Thomas G. Teates (Science Education Committee), Eugene Maurakis (Science Museum of Virginia Rep.), Jack Cranford (Director Visiting Scientists), Blanton Bruner (Executive Secretary Treasurer), Thomas W. Haas (1996 Local Arrangements Committee) Ralph Eckerlin (Public Affairs)

The meeting commenced at 1:15 pm.

1. The participants introduced themselves.
2. Tom Sitz rearranged some items on the agenda to accommodate members who had to arrive late or leave early. The amended agenda was approved.
3. The minutes of the May 24, 1995 meeting were corrected and approved. The minutes of the May 26, 1995 meeting were corrected and approved.
4. Officer's reports
 - a. President, Tom Sitz

Since Tom Sitz was incapacitated this summer, several actions were taken by ad hoc committees addressing various needs. Reports of these committees were given at this time.

Tom Sitz: During the early summer, a committee of the VAS met at the Science Museum of Virginia to review the Associate Director, Gene Maurakis', position, and the relationship between the Museum and the VAS. The meeting was taken over by Walter Witschey, Director of the Science Museum, and he presented us with an ultimatum that the operation of the Junior Academy would be taken over by the Science Museum, or we would lose the half-time position of Gene Maurakis. After the following exchange of letters, the relationship seems to have stabilized.

i. Report of the Ad Hoc Committee to Review the Position of the VJAS Associate Director, D. Rae Carpenter, Jr., Chair

Some time between June 13, and June 26, 1995, Tom Sitz received a fax memorandum from Walter R. T. Witschey, Director of the Science Museum of Virginia, in which he suggested that the Academy VJAS Committee serve as policy board and that the Associate Director (Gene Maurakis) and staff be fully empowered to run the program operations. In support of this, he said that "slippage we experienced, including Lisa's lack of availability at the VJAS office, prevented us from achieving our best." He said that either the Director should be fully empowered, or else the SMV should be fully empowered, to accomplish the program goals, saying that if this were granted, SMV would assign appropriate resources to see that tasks are accomplished, instead of "support sometimes supplied to a faculty VJAS Director." He noted that the VAS could then concentrate on setting policy, and not have to worry about whether the secretary is in by 8:30 am to answer the phone.

The VAS response to this initiative was undertaken by the Ad Hoc Committee, consisting of R. Carpenter, D. Cottingham, E. Falls, V. Remsburg, T. Sitz, and G. Taylor. The committee met on June 26, and drafted a letter to W. Witschey, which was approved by the Executive Committee, and sent on July 1, 1995. In this letter, the committee noted that G. Maurakis was responsible to the VJAS Director for 50% of his duties. The committee felt that Maurakis did an excellent job of organizing judges, but that non-VJAS duties during April and May caused him to be overloaded with VJAS demands as the meeting approached. The committee said that it was not in the best interests of the VJAS to empower the SMV to run the VJAS programs, even if that meant that Maurakis could no longer be available for any VJAS activities. The committee reaffirmed that the volunteer VJAS Director, D. Cottingham, continues to be empowered to run the program with the assistance of the VJAS Committee under the overall direction of the VAS Council. The current direction of the VJAS is towards regionalization, with a pilot program in Danville during the coming year. The committee believes that there can be positive benefits to the Museum via continuing various cooperative arrangements, and is recommending that the current part-time position of Secretary be upgraded to full time, and that this person maintain office hours at the Museum from 10 am to 3 pm, maintain a continually updated file of judges, and assist in the procurement of judges. The committee requested a copy of G. Maurakis' report of his VAS-related activities, and a copy of all VAS-related items stored in his computer, including the database of judges and all information related thereto obtained from

Lee Larkin. The committee noted that SMV Board of Trustees had approved an agreement that the VAS may rent space for a nominal fee, that having the VAS offices in the SMV would benefit the SMV, and reiterated its request for 2000 square feet, including 1000 square feet by the end of the summer. The committee expressed its appreciation for the assistance the SMV has rendered in the past and its receptiveness to future cooperation with the SMV, but said that the VAS is not yet ready to relinquish operations control of the VJAS program. On July 12, D. Rae Carpenter received a letter from W. Witschey as follows. Rae, thanks for the note. I believe that your Futures Committee has taken several very positive steps to improve the VJAS. Re-emphasizing Don's role as Director is very important. His untimely absence during critical days preceding this past conference need not be repeated in the future. Establishing a full-time secretary will be a dramatic improvement, since the complete loss of an on-site secretary this year was most unfortunate. Your request for Gene's report should already be fulfilled, as I had asked him to send you this material. I had it with me when you visited, but time didn't permit a review of it that day. Likewise, I asked him to forward to you copies of all VJAS computer files.

Rae, I'll go to work on your space needs. Your request for 2000 sq. ft. seems stunningly large for "files, computer, program storage, student papers etc." and a secretary. Is this really what's required? At any rate, we are happy to have you continue here with us in the Broad Street Station. We too are delighted to celebrate the 30th anniversary of our cooperative efforts to further science education in the Commonwealth. I applaud the Futures Committee striking forward on one of the two alternatives that I suggested to you would greatly improve the VJAS annual program. We stand ready as always to assist you and the VAS in any productive way.

Lisa Martin said that everyone at the museum is cordial, but that shortage of space was a major problem and that the museum staff was unresponsive. Don Cottingham confirmed this.

Rae Carpenter said he would look into the problem, and persist until the problems are solved.

Michael Bass asked if Gene Maurakis wasn't hired with the clear understanding that he had a half-time position for the Junior Academy. Jerry Taylor and Dean Decker said that this could probably not be proven, but that we could hope to successfully pursue previous assurances that available floor space would be provided as renovations continue.

Vera Remsburg said that previously describe exchange was not mentioned at the Trustee's meeting.

Rae Carpenter suggested that she (Vera Remsburg) should bring it up at the next meeting while he pursued response from the administrative end.

Vera Remsburg said that at the previous meeting the trustees could not speak up on anything.

Michael Bass then suggested circulating the letters to the Board.

Don Cottingham and Rae Carpenter said that the space needs were not new, but preceded Walter Witschey's directorship, and that the need for 2000 square feet had been documented for at least eighteen months.

ii. Report of the Ad Hoc Committee to review the position of Office Secretary (Lisa Martin's Position). Members Dean Decker, Art Burke, and Elsa Falls.

Elsa Falls delivered the report. The committee met with Lisa Martin on Sept 7, 1995, to develop recommendations relative to upgrading the secretary's position and to draft a job description for that position. These recommendations are included at the end of the minutes as Appendix I: Job Description for Administrative Assistant as proposed by the Ad Hoc Committee to review the position of VJAS Office Secretary.

The purchase of the computer has been expedited. In response to a question, Falls said that the money saved from reducing Blanton Bruner's salary has been earmarked for the administrative assistant's salary. Rae Carpenter added that the regular academy has not called on the trust funds for about five years, and that the amount of the salary could nearly be covered by growth in the trust funds over that period.

Discussion then turned to the job description. Elsa Falls said that no job description of the secretary's job had existed before now. Rae Carpenter said that part of the motivation for assigning these tasks was that Gene Maurakis had automated the process of procuring judges to where it could be handled by the administrative assistant.

Jim & Lisa Martin corrected this, saying that Lee Larkin automated it the procurement, but that the program he wrote would run on Gene Maurakis' computer so he did it all by hand. Jim said that besides maintaining the data base, it was necessary to contact the people, be sure that they will come, and find alternates in case they don't.

Don Cottingham and Lisa Martin said that it was a very time-consuming job, and that the Science Museum gave Gene Maurakis an inadequate amount of time to do it.

Tom Sitz called for a vote on the approval of the job description and salary of the administrative assistant.

Jerry Taylor asked that the job description not be defined by council, but that it be left up to the VJAS Director and the Executive Secretary Treasurer. This change was approved by consensus.

COUNCIL ACTION:

The Council approved the recommendations described in the report above. This approval included everything but the job description.

iii. Report of the Ad Hoc Committee to Study Academy Needs With Regard to Fund-Raising Tom Sitz asked Dean Decker to report on the Ad Hoc Committee to Study Academy Needs with Regard to Fund Raising which he did as follows. The Committee consisted of Dean Decker, Carolyn Conway, Art Burke, Richard Brandt, and Jim O'Brien. The charge of the committee was to make recommendations regarding the Academy's monetary needs to Council at the November 1995 meeting, to aid the Fund Raising Committee in its effort and to clarify points outside the purview and raised by the FRC at the May Council meeting. The report is presented below as Appendix II with changes approved by the Council at this meeting.

COUNCIL ACTION:

The Council approved the actions recommended by the Ad Hoc Committee to Study Academy Needs With Regard to Fund-Raising as amended above.

Tom Sitz reported that Dr. S. Steven Negus, the grandson of Sydney Negus, Jr., will be the next Negus Lecturer. He is an Assistant Professor at Harvard and his research field is neuro-pharmacology. Rae Carpenter added that the Negus family has increased the endowment of the Negus Lecture fund within the last five years.

4b. President-elect, Dean Decker: Duties of the year have been sent to all officers and committee members, section secretaries, and section representatives. I owe Greg Cook a short article on the scrap book.... It has been to the Junior Academy Summer meeting. It will be on the table at the May meeting, then go to the archives, and then hopefully we'll start another one.

At this time, various officers corrected their addresses for inclusion in the next directory including Dean Decker: Decker@urvax.urich.edu, home phone 804-285-2980; Carolyn Conway: cconway@felix.vcu.edu; and Greg Cook: Gcook@infonet

Greg Cook asked for people to send directory corrections to him for inclusion in the next newsletter.

4c. Vice President Carolyn Conway: As this is a new office, Carolyn invited suggestions for her role in the academy. She announced a change in the way meetings will be handled this year. In the past, abstracts have always been collected by mail in April. A survey of section representatives revealed that only one section was making copies of the abstracts available at the meeting. Therefore we will now have the abstracts due at the meeting, which will remove the risk of them being lost in the mail. Sections which wish to collect them early will receive instructions on how to handle that. Responding to a question from Jerry Taylor, Carolyn said that the section editor should be responsible, rather than the Section Secretary.

4d. Secretary, Joseph W. Rudmin: No report

4e. Treasurer, Greg Cook: No report

4f. Executive Secretary-Treasurer, Blanton Bruner: Report given by Lisa Martin. Blanton sends his regards, and he suggested that someone write a letter as has been done in previous years, but not recently, to institutions and businesses who are members of the Academy, thanking them for their support and also a request for continued support. Tom Sitz said he would take care of that.

4g. Elsa Falls, 1994-5 past president. Concerning the resolution which was passed last May by the Council and the Academy Conference regarding the importance of laboratories in science. That resolution was forwarded to all heads of institutions of higher learning in Virginia, as well as to appropriate government officials in the state. It was published in the Virginia Journal of Science and will be published in the next Virginia Scientists. I also called Beverly Orndorff about the resolution, and I hope some of you saw the article in the Richmond Times-Dispatch. Of over one hundred letters sent out, I got just one response, and that was from Gordon Davies, director of SCHEV. He thanked me and said "We agree with you, and urge that students have laboratory experiences in science courses." I want to thank Marion for initiating this process, and her subcommittee for writing it. Carolyn Conway asked if any college administrators had acknowledged seeing this. There was no response. Don Cottingham said both the Virginia Science Leaders

Association and the Virginia Association of Science Teachers have passed similar resolutions.

4h. James O'Brien, 1993-4 President: Jim distributed sample documents to be sent out in the first mailing. These included a letter of appeal signed by members of the Council, a list of Categories of Giving, a fact sheet recounting highlights from the history of the Academy, a two-sided pledge form designed for three-panel folding, and a selection of possible logos for the Legacy 75 Campaign. He also distributed a sheet recounting the history of his appeals to the Council for 100% pledge participation.

He distributed a written report of the fund-raising committee which is summarized as Appendix III.

MOVED: That \$3000 be [transferred from the General Fund held by the trust committee] to establish a new Academy fund--the VJAS Research Endowment Fund. Proceeds of this fund, upon the recommendations of the Trust Committee and with the approval of Council, will be allocated annually to the VJAS Research Grants Program and to the increase of this fund's corpus.

Note: The bracketed words were added by Council, and it was approved in this form.

Jim O'Brien requested clarification of the Donor-designated funds as described above under LEVELS OF DONATIONS BY AMOUNTS: item 3. Rae Carpenter explained that Endowments would be given their own stock accounts with excess earnings going back into that account, whereas donor-designated funds were part of the general account, and any earnings above 10% would revert to the general fund.

Jim O'Brien then brought to the floor the motion in the report to create an endowed VJAS research fund. After some discussion this was approved.

COUNCIL ACTION:

The Council approved the creation of the VJAS Research Endowment fund as worded above.

Jerry Taylor then raised the question of what has become of the profits of the annual meeting for the last several years. This was discussed without a clear answer being given.

4i. 1992-3 President Golde Holtzman: No report

5. Local Arrangements Committee Reports

5a. 1995-VMI: Rae Carpenter and R. B. Minnix:

Rae Carpenter distributed a detailed financial statement of the meeting which gave income of \$59,959.45 and expenses of \$24,514.07. The difference, \$35,455.38, was sent to the Executive-Secretary Treasurer for the Academy accounts. That income includes some dues paid at registration. He said that VMI funds covered the cost of the building. The major expense was food services. Exhibits showed a 200% profit.

Dean Decker: The dues are typically around \$1000.

Rae Carpenter: The Science Museum of Virginia sent the Airmobile with no assurance of payment. We gave them \$150 which satisfied them. We owe them a thank you for sending it.

Rae now gave the Trust Committee Report. He distributed a list showing the breakdown of funds, including the General Fund, the Fellows Fund, the Research Fund, the Bethel High School Fund, the VJAS Endowment Fund, and the Legacy 75 Fund. The assets of all together total \$388,136 as of Nov 3, 1995, which represents a growth of \$90,000 since December 1992. Market value increased 19.8% this year even after \$8000 in disbursements were deducted. We have been allocating 10% for academy purposes, even though we haven't been drawing that much. But the interest on the funds has well covered that.

Joe Rudmin asked if the Legacy 75 mailings should include a phone number at which people can get information about the funds they may contribute to. Jim O'Brien said that there was insufficient space on the brochure.

Dean Decker said that the mailing should direct questions to the Executive Secretary-Treasurer.

5b.1996 VCU Local Arrangements Committee, Tom Haas Chair, Carolyn Conway reporting:

Carolyn reported that things are going well and ahead of schedule.

Lisa Martin asked what to do with boxes of T-shirts, etc, which had been delivered to her office. Carolyn Conway said she would take care of them.

5e.1997 Virginia Tech Local Arrangements Committee, John Hess and Tom Sitz co-chairs, Tom Sitz reporting.

Tom Sitz said that the dates had been chosen, and things were going smoothly.

6. Directors' and Representatives' Reports

6a. VJAS, Director Don Cottingham

i. 1996 meeting at VCU: He said that it will be a great meeting, with the entire meeting in just two buildings. Some changes will be made. We are changing from a minimum of 3 readers and judges for each paper to 2. The Session Chair will serve as a tie-breaker. Interest in the VJAS is still growing. We had 1960 papers last year, and expect over 2000 this year.

ii. Don said he will definitely retire after the 1997 meeting, and will need a replacement.

iii. Regionalization of the VJAS Regionalization in the Southwestern part of the state is progressing, but a regional director is needed. All the groundwork has been laid, and the community colleges are supporting it, but without people we can't proceed. One objection is that we're only starting it in one area of the state, so the people in that area have to go to one extra meeting, and that may just be too much for some people, especially when they see that the rest of the state doesn't have to do that.

Lisa Martin asked if he had a VJAS member from the Danville area in mind. Don said he did, but wanted to meet with them personally.

Jerry Taylor suggested asking presidents of community colleges to provide a regional director, since community colleges in that area of the state have suffered enrollment drops and might welcome such a position.

Don Cottingham said he had met personally with each president and with their aides, and asked them for names of people that could do this. They gave him names of three people, each of whom declined when approached. One was a high school teacher with three small children, who probably could not have handled it. Jerry

Taylor said that he was suggesting getting a president of a community college to commit a faculty member's time.

Don Cottingham said that he hadn't approached it from that angle.

There was a discussion concerning the need to make more progress in regionalizing the Junior Academy. Council members commenting included Jerry Taylor, Don Cottingham, Marion Lobstein and Jim Martin. Points raised in the discussion included the need to get a regional director and the inability of overworked community college faculty to fill the need on a volunteer basis.

6b. Visiting Scientist Program: No Report.

6c. AAAS Representative Ertle Thompson

Ertle reported that he is looking forward to the meeting in Baltimore.

6d. Science Museum of Virginia Trustee Vera Remsburg

Vera described the progress of renovations at the Science Museum and the rapid progress at the branch opening at the Danville train station. It will open in December, with all the exhibits on line. A new director and trustees have been appointed for the Danville Museum, and the Trustee's meeting will be held there in April. Future plans are to remodel and finish the Broad St. Station, for which the Museum is seeking eight million dollars from the Assembly. Vera described a representation problem. The Code of Virginia, Chapter 18, The Science Museum of Virginia, section 23-243, under Educational Institutions requires that one member of the Board of Trustees must be a member of the Virginia Academy of Sciences. The problem has been the appointment of a member of the VAS who has not been approved by Council, which evades the spirit of the statute. The Board is made up of a lot of people who are not scientists. They are money-making people in a thirty-million dollar campaign. Vera has decided to appeal in person to the Executive Board, which is the power of the Board of Trustees, to present the Academy's case. She will do this in consultation with Rae Carpenter.

6e. Jeffress and Gwathmey Memorial Trust Allocation Committee, Richard Brandt reporting: The next meeting of the Allocations Committee is Nov 16. The Gwathmey trust is for charitable allocations, and at the next meeting there will be about \$300,000 awarded for the forty requests submitted, while the Jeffress awards will total about \$570,000. There are eight renewal applications and forty-two other requests have been submitted, for scientific projects. The proposals are sent out to experts for review and then summarized for the Allocation Committee by the "Advisor", J. Samuel Gillespie, Jr., Ph.D. Higher priority is given to proposals from junior faculty. Awards are made by with the advice of an Allocations Committee. Richard submitted to the secretary a brochure describing the Jeffress Memorial Trust, and giving guidelines to applicants. Proposals and correspondence concerning grants should be addressed to J. Samuel Gillespie, Jr., Ph.D., Advisor; Trust Division; NationsBank of Virginia, N.A.; PO Box 26903; Richmond, VA 23261; Telephone 804-788-2964; Fax 804-788-2700.

7. Standing Committee Reports

7a. Archives Committee, Golde Holtzman, No report.

7b. Awards Committee, Chair Robert E. Johnson, no report.

7c. Constitution and Bylaws Committee, Co-chairs Michael L. Bass and Gerald

R. Taylor, Jr., G. Taylor Reporting

Jerry Taylor: Item 1. At the last Council meeting, as shown on page four of the minutes of the May 26 meeting, the Council approved a motion to raise the cost of Life Membership to \$500, and to distribute this to the membership. So I move, since this has been distributed, that the cost of life membership be raised to \$500.

COUNCIL ACTION: This motion was approved unanimously.

Jerry Taylor: Item 2. On page 5 of the minutes of May 26, Council approved a change in By-laws Article I, section 4, to read, "They shall have all the rights and privileges of membership for one year". That motion passed unanimously and has been distributed to membership. So I move that we approve the Bylaws change of Article I, Section 4, to read "They shall have all the rights and privileges of membership for one year."

COUNCIL ACTION: The motion passed unanimously.

Jerry Taylor: Item 3. Same page, section 4, "Patrons shall be those persons who have given to this organization the sum of one thousand dollars or its equivalent in property." And I'm not quite sure what we have to move on that, but it was distributed, and I guess I move formally that "Patrons shall be those persons who have given to this organization the sum of one thousand dollars or its equivalent in property."

Tom Sitz: That's for a period of one year. We changed the wording slightly.

COUNCIL ACTION: The motion passed unanimously.

Jerry Taylor also delivered to the Secretary (Joe Rudmin) the following clarification.

RECOMMENDATION FROM THE CONSTITUTION AND BYLAWS COMMITTEE THAT WAS SUBMITTED TO VAS COUNCIL, MAY 26, 1995 AND APPROVED BY COUNCIL FOR SUBMISSION TO MEMBERSHIP BYLAWS OF THE VIRGINIA ACADEMY OF SCIENCE

CURRENT WORDING OF ARTICLE I: TYPES OF MEMBERSHIP

Section 3.

Life members shall be individuals who elect to pay to the Academy the sum of three hundred dollars (\$300.00) and thereby become exempt from further payment of dues.

Section 4. Patrons shall be those persons who have given to this organization the sum of one thousand dollars (\$1000.00) or its equivalent in property. They shall have all the rights and privileges of Regular Members and shall be exempt from dues. An institution may also become a Patron by meeting the above requirement. Its representative shall have all the rights and privileges of regular members.

APPROVED CHANGE IN WORDING OF ARTICLE I: TYPES OF MEMBERSHIP

Section 3.

Life members shall be individuals who elect to pay to the Academy the sum of five hundred dollars (\$500.00) and thereby become exempt from further payment of dues.

Section 4.

Patrons shall be those persons who have given to this organization the sum of one thousand dollars (\$1000.00) or its equivalent in property. They shall have all the rights and privileges of membership for one year. An institution may also

become a Patron by meeting the above requirement. Its representative shall have all the rights and privileges of regular members.

NOTE ADDED AFTER THE MEETING BY THE SECRETARY, JW RUDMIN

A re-examination of the minutes of the May 26 meeting shows that there were not three, but two items of change in wording approved by the Council for submission to membership. Following this was a clarifying statement of the new wording.

The third motion passed in the above preceeding discussion was not wrong, but was redundant. Therefore the third motion is invalid and under the constitution has no effect. It had no effect for the additional reason that it approved a wording which was already in effect.

Jerry Taylor: I would like to express our recognition to Jim Martin, Editor of the Journal for his efficiency. Those changes are in the Bylaws distributed in the Journal here today. (Laughter)

7d. Environment, Chair Michael L. Bass

MB: We had a successful meeting. We started at 10:30 on Friday, and heard several papers. After lunch several of us continued talking until 1:30. Most of what I heard was positive.

7e. Finance and Endowment, co-chairs Arthur W. Burke, Jr, and Paul J. Homsher Elsa Falls reporting.

Elsa Falls began by noting that she is not a member of the committee, but is only delivering their report. She noted several items in the report. First, the proposed budget for 1995 reflects an expected decline of 9% in income, and a budgeted increase of 8.5% in disbursements. The committee therefore urges the Council not to increase any expenditure without a compensating decrease in another. The decrease in income is due to an expected \$2000 decrease in dues, mainly offset by an increased yield of the "general funds, as so well managed by the Trust Committee." The Academy has not withdrawn any money from the trusts in recent years. The Finance and Endowment Committee recommends to Council that dues for 1996 be increased by one dollar to be credited to the Legacy 75 campaign. Elsa said that the Executive Committee felt that this could not be done without a change in the Constitution and Bylaws. A suggested alternative is to add a line on the membership form requesting an optional donation to the campaign. The itemized budget, with corrections and modifications made by the Executive Committee, and as approved by the Council, is shown as Appendix I of the Minutes of the Executive Committee Meeting on Nov 5, 1995.

The increase in salaries is partly due to increasing the Executive Assistant's time commitment, and partly due to a 5% raise. This is partially compensated by a reduction in the salary of the Executive Secretary.

Questions were raised about the income from the meeting and the expenses for the meeting.

COUNCIL ACTION: The budget was approved with one dissenting vote.

(The dissenter said he didn't understand the budget.) The widely expressed sentiment was that it was incomprehensible, but that the Council members trusted the Executive Secretary and his assistants.

Questions were also raised about the costs of Social Security and benefits for the Executive Secretary.

7g. VJAS Committee report was given earlier

7h. Long Range Planning Committee, Chair Richard Brandt, no report

7i. Membership Committee, Co-chairs Scott H. Newton and John P. Morgan, no report.

7j. Nominations and Elections Committee, Chair Golde I. Holtzman, no report.

We seek suggestions from Council for nominations for people for various offices.

7ki. Publications Co-chair Virginia Journal of Science Editor James H. Martin
Our rejection rate is up to 65 to 75% now. Submitters should be more careful to proofread their papers.

7kii Publications Co-chair Virginia Scientists Editor Gregory C. Cook

You've all noticed that I've had trouble getting an issue out lately, but there is one in the works which should be in your hands soon. My term expires in 1996. Please be thinking about a replacement. I will no longer be able to do it.

However I am now ready to put the Academy on a Website. This was approved by the Executive Committee this morning, and I will accept suggestions.

7l. Research, Judy Niehaus Chair, no report

7m. Science Advisory, Chair William L. Dewey, no report

7n. Science Education, Co-chairs Thomas G. Teates and Maurice P. Lynch
Elsa Falls reporting

Marion Lobstein: Last spring when we raised the issue of the importance of laboratories in science education, another issue came along with it, and that is the equity of credit for teaching labs. This varies greatly throughout the state. In many institutions within the college system you get essentially half a credit in your teaching loads for teaching labs. Gerald, I think at JMU you're getting one credit. I'd like to know what credit you get for your lab teaching, compared to lecture hours. Some of our community college teachers down state are teaching twenty-eight contact hours per week, compared to fifteen at the four year colleges. We're finally at eighteen at NOVA, and find our president would like to push us up to twenty-one to twenty-four, still leaving faculty in the humanities and math at fifteen and it's just not right. I don't know how strong the feelings are at other institutions throughout the state. Do you think this is an issue that Council should try to bring forth to the general membership?

Tom Sitz: This fits in very well with the previous resolution, because in a way it cheapens the laboratory teaching.

Joe Rudmin: I'm carrying eight hours of labs for which I'm getting four hours of credit, but that's a lot easier than carrying eight hours of preps. We do have to face that fact that a two-hour lab is more like a one-hour prepared lecture, when you include the preparation load. (Many voices of disagreement here)

Elsa Falls: It depends on what it is and how much you interact with your students. You have to be more on your feet in a lab because you're dealing with the students one-on-one.

Ertle Thompson: Also, it depends on how much physical preparation you do for the lab. Some of these people have no lab assistants. They do all of the preparation for the lab themselves.

Jim Martin: Another point is that when an English teacher teaches three credits, he has thirty-five or forty students in the classroom. We're stuck at twenty-four in the lab.

Dean Decker: But by the same token, I've had lectures in recent years in which I've gotten the enrollment down to sixty. We've had eighty to ninety in some lectures. My teaching load was two lecture three-hour lecture courses and three two-hour labs for a total load of twelve hours. The student load was around two hundred fifty. That far surpasses a History or English class of thirty-five or forty.

Sandra Welch?: I think we have to look at it from the students' point of view too. I really want one-hour one-credit all across the board, not just for faculty teaching loads. My students in a three-hour lab keep lab notebooks, write reports, and come in prepared for that lab. They say they do more work for that one credit of three-hour lab than they do for an English course and a Philosophy course put together.

After some further discussion, Tom Sitz and Marion Lobstein decided that the issue should be further pursued by a subcommittee of the Committee on Science Education. Marion Lobstein circulated a sign-up sheet for those who would like to participate in this subcommittee.

Elsa Falls: This has been a major discussion issue on the list-server of the Council on Undergraduate Research.

Robert Berquist?: Will the Council have an opportunity to review this before it goes to the Academy Conference?

Tom Sitz: Yes.

Marion Lobstein: Last spring we tried to get a copy of the resolution out to the Council before the Academy met.

Jim Martin: You have until the March meeting to get a preliminary version to the Council, and then between March and the May meeting we can get everything right. Jerry Taylor: I'd like to bring up a related item.

Tom Sitz: If this is related, let's do it now.

Jerry Taylor: The State Council on Higher Education for Virginia is undertaking a review of all Physics programs in the state of Virginia with a view to eliminating waste and duplication. This will have a major impact on the faculty and students in the state physics programs.

Tom Sitz: Why are they picking on Physics?

Jerry Taylor: They aren't picking on Physics. Physics is the one they're starting with. The State Council has an advisory committee of people from the state and all over the country.

Vera Remsburg: Did the Director appoint these people?

Jerry Taylor: I guess Gordon Davies effectively appointed them. The Chair of the UVA Physics Dept. is on the committee, and may be the Chair, Dan Larson. Others are Judy Franz, Executive Director of the APS, Brian Schwarz. They want to eliminate duplication of effort, and I'm told they're going to eliminate some programs in the state in some disciplines.

Tom Sitz: Are the two-year schools involved?

Jerry Taylor: Majors. I guess it's the four-year schools.

Tom Sitz: Do you want to put something together on this, Jerry?

Jerry Taylor: It would be very bad for us at JMU to do this. We've just been through the grind, and now we're going to do it again with a site visitation in December.

Tom Sitz: Can you get some of your Physics colleagues to carry the ball on this? Joe Rudmin: What Jerry is saying is that Physics people shouldn't be carrying the ball on this, because we obviously have a vested interest.

Marion Lobstein?: This is one of several such issues in which we have a conflict of interest. Credit for teaching laboratories is one. We at the community colleges don't have tenure, but I've been asked to serve on a committee to review tenure in the state.

Jerry Taylor: Concerning that, SCHEV has already decided to begin Post-Tenure Reviews at all institutions. Post-tenure review means a way of eliminating tenure contracts. It's basically doing a review every three to five years, setting up goals and objectives and future planning. The process is running right now. As far as the Physics part of the program, the information can be gotten by calling up SCHEV.

Vera Remsburg?: With this kind of situation in the Physics program, it's what we were facing last year with the legislature. Something HAS to be done now. If Council could pass a resolution stating the importance of maintaining strong programs in science, now is the time to do something. By spring, Jerry, it's going to be a done deal.

Tom Sitz: Would you like a letter from the President of the Academy? It's better than nothing.

Jerry Taylor: How are you going to write a letter about an issue that's being reviewed in December and January until you can find out what's happening? I suggest you ask the Public Affairs Committee to find out what's happening.

Marion Lobstein: This issue of lab credit has to be done, but this is another whole issue, Jerry, and something needs to be done now.

Ertle Thompson : Jerry, to whom could the President address a letter requesting information about what is happening? It seems to me that would be the logical thing to do.

Jerry Taylor: Both to him and the Secretary of Education.

Ertle Thompson : Right. It seems to me that what's happening is that SCHEV is reacting to the Secretary of Education.

Tom Sitz: If Council would like, I can go ahead and get information, and I'll get together with Jerry to work out the phrasing. I'll get a letter out this week. Jerry Taylor: Right, and find out what other programs are going to be looked at next.

Ertle Thompson : We went through this eight years ago, when they looked at all the teach-certification programs in the state. We had thirty-six programs preparing and certifying teachers. We were going to eliminate at least 40 to 50 percent of those. We ended up with approved programs for thirty seven institutions. There isn't a four-year school in the state that does not have an approved program for teacher certification. And don't ask anybody at the State Council or the Department of Education to describe those programs for you. They can't do it.

Jerry Taylor: But there's one more thing that needs to be added to that. Education majors were eliminated in the state.

There was some more discussion on teacher certification programs.

Tom Sitz: I'll write some letters and get some feedback, and then see where we go from there.

7p. Virginia Flora Committee, Chair Rex Baird, Marion Lobstein Reporting.

Marion Lobstein: We are really excited about the creation of WorldWideWeb site. I'll have the person whose doing it see if she can tie her efforts in with yours.

Lisa Martin: Is that Web site going to be for the Junior Academy too? I think that's where you can hit first and hardest.

8. Special Committee Reports

8a. Futures, Chair Rae Carpenter, Jr. has already reported.

8b. Public Affairs, Ralph Eckerlin. No report

8c. 75th Anniversary Committee, Chair Golde Holtzmann

Golde distributed a sheet showing various logos under consideration. He said that this was just the beginning of the Committees activities.

9. Section Representatives' Reports

9a. Aeronautical & Aerospace, Fred Lutze, no report

9b. Agriculture, Forestry, and Aquaculture, Scott Newton, no report

9c. Archaeology, Eugene Barfield. The Archaeology Section looks forward to meetings in 1996 as successful as those of 1995. Over twenty papers were presented including a thematic group on Archaeology of African American Excavations. These will be published in a special publication of the Archaeological Society of Virginia next year.

9d. Astronomy, Math, and Physics, Gerald Taylor, The Section is doing well.

9e. Biology, Carolyn Conway. Biology is doing well.

9f. Biomedical and General Engineering, Eleni Achilleos and Penny Pagona. No report

9g. Botany, Marion Lobstein. Botany is flowering.

9h. Chemistry, George Mushrush, no report

9i. Computer Science, Robert Willis, no report

9j. Education, Pamela Turpin, no report

9k. Environmental Science, Michael Bass, report given earlier.

9l. Geography, Steve Wright, no report.

9m. Geology, David Walz, no report.

9n. Materials Science, Kenneth Lawless, no report.

9o. Medical Sciences, Sandra Welch, Medical Sciences is doing well, we are recruiting new students.

9p. Microbiology and Molecular Biology, Francis Macrina. Tom Sitz said that he would push to have the section meet at VPI next May.

9q. Natural History and Biodiversity, Michael Kosztarab, no report.

9r. Psychology, Robert Berquest, Gerald Taylor delivered the report. Psychology is alive and well with work progressing for the annual meeting. Public relations are ongoing for Junior Academy papers, plans are being made for processing them. We remind that assistance is required for storing the papers and judging them at the Annual Meeting. The Virginia Psychological Foundation was not notified of the 1995 Psychology Section awards. Considering their support, the list of winners should be sent to the Foundation each year.

9s. Statistics, Golde Holzmann. "Normal Deviants" (laughter)

10. OLD BUSINESS:

Jerry Taylor: As a consequence of the meeting of Vera Remsburg, Rae, Don Cottingham, Elsa Falls, and myself, meeting with Walter Witschey this summer, the consequences of which you know, when we met following up that VMI-designated Ad Hoc Committee, I would like to have the minutes show that we wish to recognize the dedication and service which Don Cottingham has shown in extending his tenure as VJAS Director, and the tremendous job which he has done and is continuing to do.

COUNCIL ACTION: The Council unanimously voted to extend this recognition.

11. New Business

a. Regional Science Museums

Marion Lobstein reported about the new Museum of Natural History in Martinsville. They are very actively taking science to the public, on a shoestring budget. She requested that council think about giving them some support, and offered to put anyone interested in contact with them.

Vera Remsburg said that we supported them last year in their effort to retain their state funding. She said that they have done an excellent job in the southwest corner of the state.

Marion and Vera likewise praised the Danville Museum?

Jerry Taylor suggested approaching them to direct the southwest region of the VJAS. Golde Holtzmann said they have a strong link with Michael Kostrov, who is an active VPI emeritus professor who has had a good relationship with the Academy.

b. Increasing Industrial Participation

Joe Rudmin expressed the opinion that the Academy needs more participation from scientists in commerce and industry.

12. Concluding Remarks.

Tom Sitz thanked the Council members, especially Rae Carpenter, Elsa, Dean, and Don, for handling the emergencies which arose during the summer when he was incapacitated.

The meeting adjourned at 5:20 pm.

-----Appendix I.
Job Description for Administrative Assistant as proposed by the Ad Hoc Committee to review the position of VJAS Office Secretary.

The following recommendations were made in a written report distributed to Council.

I. As a stop gap measure: That the secretary begin to maintain regular hours on a daily basis (M-F) from September through December 1995 at the VAS office, and that her salary be increased \$125 per month for each of those four months as compensation for her time. (This recommendation was approved by members of the Executive Committee by phone on Sept 11, and Blanton Bruner has implemented the recommendation.)

II. As soon as possible: That Jim Martin be asked to explore the purchase of an additional computer and printer by VAS to be kept at the Martin residence for the use of both Jim and Lisa. It and its software should be compatible with the current machine owned by the VAS, which is to be housed at the VAS office.

III. Effective Jan 1, 1996: A. That the VAS office be staffed six hours a day (10 am to 4 pm) five days a week from Labor Day to Memorial Day. Hours would be more limited from Memorial Day to Labor Day. Lisa Martin would be present from 12-4 pm, and Blanton Bruner and Art Burke would divide hours 10-12 noon.

B. That Blanton Bruner (at his request) begin to curtail his responsibilities as Executive Secretary-Treasurer. His yearly salary would be decreased by half for 1996 (from \$8000 to \$4000).

C. That Art Burke be appointed as Associate Executive Secretary-Treasurer and begin to assume more of Blanton Bruner's duties. There would be no remuneration for his services (at his request).

D. That the position of administrative assistant be designated as three-fourths of full-time. ("Job description attached" was removed here by Council vote.)

E. That Lisa Martin be appointed Administrative Assistant, and that her salary be raised to reflect this increase in time commitment from half to three-fourths time. (This increase is in addition to any increase proposed as an annual raise based on job performance.)

F. That VAS continue to contract with an employment service to provide checks and benefits for the Administrative Assistant.

IV. Job Description for Administrative Assistant

A. Purpose:

1. To assist VAS Executive Secretary-Treasurer and VJAS Director with their administrative responsibilities.

2. To assure the effective operation of VAS office, to include having someone (Administrative Assistant or other) in that office approximately six hours a day, five days a week.

3. To facilitate the work of VAS Executive Committee and Council, and the VJAS Committee.

B. Primary Duties and Responsibilities

1. VAS

a. To prepare and mail out VAS membership invoice forms.

b. To inform appropriate state and national organizations regarding current officers, meeting dates, etc.

c. To supply mailing labels for Journal, Virginia Scientist, Section Secretaries, Call for Papers, Meeting Program, etc.

d. To prepare monthly financial statements, quarterly reports, etc. and distribute to appropriate persons.

e. To keep membership lists current, including address changes.

f. To serve as secretary to Executive Secretary-Treasurer, and assist him as needed with bookkeeping.

g. To prepare certificates and/or plaques for various award winners.

h. To help insure that Schedule of Responsibilities is followed by VAS officers.

i. To insure that materials for printing of Journal and meeting programs and mailing labels are sent to and received from printer.

j. To answer phone and supply information and direct callers to appropriate officer/member.

k. To send annual budget (RFP) letters to appropriate officers and committee chairs.

2. VJAS

a. To identify award winners and send congratulatory letter signed by VJAS Director and to mail unclaimed certificates and award money to winners (after May Annual Meeting).

b. To attend summer VJAS Committee meeting, confirm volunteers to edit papers, distribute directory of Committee members, and obtain appropriate signatures on membership cards and club certificates.

c. To send fall (1000+), winter, and spring membership information letters to Virginia schools, record club memberships as received, and send membership cards and certificates.

d. To plan for and attend winter VJAS Committee meeting.

e. To receive and process VJAS papers (in March).

f. To send rough draft of program and registration packet to clubs and individual members and make certificates for all presenters (in April).

g. To prepare materials, certificates, and script for Annual Meeting (in May).

h. To monitor stationary and envelopes and to provide to appropriate people.

i. To insure that printing of program for Annual Meeting and all other copying is accomplished in most efficient and cost-effective way possible.

j. To process incoming and outgoing mail.

k. To answer phone and supply information and direct callers to appropriate officer/member.

l. To prepare Proceedings.

C. Annual Review

The job description and performance of the Administrative Assistant shall be reviewed on an annual basis by a committee appointed by the VAS President; the committee should include the Executive Secretary-Treasurer and the VJAS Director. The results are to be reported to VAS Executive Committee before its fall meeting for appropriate action.

D. Tenure

The appointment of the Administrative Assistant is renewable on January 1 of each year. Should either VAS or the Administrative Assistant desire to terminate this relationship, a notice of at least two calendar months is considered appropriate.

APPENDIX II: Report of the Ad Hoc Committee to Study Academy Needs With Regard to Fund-Raising. The Committee defined the following terms.

ENDOWMENT/ENDOWED: Funds or property donated to a recipient as a SOURCE OF INCOME (the income from the endowment to be used as directed at the time of the bequest leaving the principal intact)

AMED ENDOWMENT: An endowed activity named by the donor for a person(s), place(s), or organization(s).

VIRGINIA ACADEMY OF SCIENCE: (also known as the "senior" academy or VAS) References made to the Virginia Academy of Science include all activities of the VAS except the Virginia Junior Academy of Science. Activities include, but are not limited to the expenses of the office of the VAS and Executive Secretary, publications, research grants, and any Council-approved expenditures.

VIRGINIA JUNIOR ACADEMY OF SCIENCE: (also known as the "junior academy" or VJAS) Activities include, but are not limited to, the activities of the office of the VJAS beyond those of the VAS office, publications, awards, and any VJAS Committee and/or VAS Council-approved expenditures. The committee noted that although the VJAS is part of the VAS, for purposes of fund-raising it is advantageous to separate the VAS and the VJAS, because some donors will contribute to the VJAS and its secondary school activities, who would not do so for the VAS and its activities.

RECOMMENDATIONS: The ad hoc committee recommends to the VAS Council the following possible categories to be used in soliciting monies for the relatively immediate goals of the VAS and VJAS. Longer range goals and objectives should be defined by the Long Range Planning Committee in conjunction with Council and the Fund Raising Committee.

VJAS: The most pressing need of the VJAS is to reasonably assure the continuation and expansion of the VJAS awards and the system involved in its operation. The current program awards approximately \$25000 in cash awards, trips, and scholarships. Some of these awards are endowed, others depend upon contributions which must be solicited annually. The section awards, approximately \$5000, come from one donor, currently Virginia Power, who replaced the previous donor after more than 25 years of contributions. Virginia Power has indicated that their period of contribution is limited, thus the need to secure these awards. These awards are very attractive to potential donors.

VJAS DIRECTOR & ASSOCIATE DIRECTOR: The past history of management of the VJAS has been entirely on a volunteer basis. This volunteer management may be part of the appeal of support for the VJAS that the VAS members have when asked to serve the VJAS. The growth of the VJAS to become one of the largest and best in the country has pushed the management of the VJAS beyond what can be continued on a reasonable basis by volunteers, particularly the leadership aspects. Therefore, some level of a paid director and/or associate director is needed. As the work load currently is predictable but sporadic, the paid leadership may range from one person part-time to more than one person full-time. The immediate needs are to be met by increased volunteer efforts and the increase in the responsibilities and time-commitment of the currently salaried secretary.

VAS: It is nearly certain that there will soon be changes in the office of Executive Secretary/Treasurer. This topic should be discussed by Council as potential changes occur. However, this item was not part of this committee's deliberations as it should not be a part of fund-raising activities. The Constitution and By-Laws of the VAS stipulate that in addition to "fellowship amongst members", Education and Research are activities of intended pursuit. The principal Educational activity of the VAS is the VJAS. This is particularly true when considering fund-raising, participation, and accomplishments. Other educational activities need to be determined and refined by the Long Range Planning Committee. The VAS does have a modest research support program, most of which is endowed. These funds primarily aid young beginning researchers, but are not limited to that endeavor. This committee recommends that part of the fund-raising efforts be directed to increasing the monies available for this program of the VAS.

DISCRETIONARY FUNDS: (at the discretion of the VAS/VJAS management) It would be desirable to the academy to have all funds as discretionary. However, donors often prefer to designate the role their donations will play and put limitations on the donation. The appeal for funds of the discretionary type applies to both the VAS and the VJAS. **SUMMARY:** This committee discussed guide lines regarding amounts to be solicited in various categories and how those monies would be used by the Academy.

Endowment-intended gifts (money of other forms converted into money) should anticipate a conservative, reasonably guaranteed 5% return that would constitute the Academy's usable funds. However, with the 5% guaranteed for academy use, any excess can be reinvested to compensate for inflation. Should inflation be met with excess, the Council could approve some additional use of endowment revenues.

LEVELS OF DONATIONS BY AMOUNTS:

1. Named Endowments must be \$5000 or more, and must be approved by Council.
2. Unnamed Endowments must be \$3000 or more, and must be approved by Council.
3. A NEW donor-designated fund must be \$1000 or more, and must be approved by Council.

(NOTE: Donations exceeding \$5000 could or would carry a name with the money distribution, such as the Bethel High School Scholarship, and the Horsley Research Award. Donations of at least \$3000 would be accompanied with the statement that the awarded monies were made possible from a gift from the donor. Gifts of \$1000 or more would be independently noted and published at least annually by the VAS and/or the VJAS. Contributions of less than \$1000 would be acknowledged at the time of contribution only. It is understood that any donor of any amount who wishes anonymity would be granted it.)

It is a recommendation of this ad hoc committee that whenever possible, funds be deposited in existing accounts under the management of the Trust Committee. Establishment of new accounts should be discouraged. With computer-tracking, the Academy has sufficient accounts to handle almost all donations.

Appendix III. Report of the Fund-Raising Committee to the Council, Nov 5, 1995.

Notes: Thanks to all the Council Members who have made pre-campaign minimum Leadership pledges, and to Rae Carpenter and Vera Remsburg for their supportive letter. Thanks to Elsa Falls for helping to edit the Legacy 75 pledge form, to Alan Branigan for his years of service on the fund-raising committee. Welcome to George Grant.

I. Progress on External Campaigns

A. Virginia Scholarships Task Force

Twelve members, coordinated by Steve Wright, have agreed to serve on a task force for the purpose of soliciting scholarships of the next year and a half from their host institutions. The Task Force includes Ann Fabirkiewicz (R-MWC), Kenneth Lawless (UVA), Ali Mohamed (VSU), James Poland (VCU), Golde Holtzman (VPI&SU), Dean Decker (UR), Gerald Johnson (W&M), Harold Marshall

(ODU), Douglas Mose (GMU), Robert Willis (HU), and Rosemary Barra (MWC). More volunteers are sought.

B. Honorary Committee This committee will consist of prominent Virginians who are being recruited to participate in the campaign. Past President Maurice Rowe and Jim O'Brien are working to assemble this committee, and ask for suggestions, which so far include T. Marshall Hahn, Linwood G Holton, Owen B. Pickett, Gerald McCarthy, and Mills Godwin.

II. Progress on Internal Campaign

A. Council Support

Of the 51 members of the 1994-5 and 1995-6 Councils, 21 have pledged Leadership Pledges. 72% of the current Councilors have taken some action, including 3 who signed the letter, but have not pledged, and 3 who are members of the FRC, but have not otherwise participated.

B. Total Leadership Pledges, Donations Received, and Commitments Council members have pledged \$12,825 of which \$1,295 has been received. Other VAS members have pledged \$2300 all of which has been received. The JMU Scholarship has been pledged to an amount of \$2000, of which \$1000 has been received. Six individuals have pledged over \$1000, and these total \$9575 of which \$3150 has been received.

C. Legacy 75 Member Appeal

A bulk mailing to all VAS members will be sent before Dec 1995. It will contain the following items: An appeal letter signed by Council members with a list of the categories of giving on the reverse side, a Fact Sheet giving highlights of the history of the VAS, and a Legacy 75 pledge form designed for folding into a 3-part packet. Follow-up appeals by mail or phone may follow. The Categories of Giving were developed in consultation with Rae Carpenter and are based on recommendations of the Ad Hoc Advisory Committee and approval of them by Council is requested. Council is requested to pass the following motion establishing the VJAS Research Endowment Fund so that it may be in existence prior to the Legacy 75 appeal to members.

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Membership in the Academy is organized into sections representing various scientific disciplines as follows:

- | | |
|--|---------------------------------------|
| 1. Agriculture, Forestry & Aquaculture | 10. Psychology |
| 2. Astronomy, Mathematics & Physics | 11. Education |
| 3. Microbiology & Molecular Biology | 12. Statistics |
| 4. Biology | 13. Aeronautical & Aerospace Sciences |
| 5. Chemistry | 14. Botany |
| 6. Materials Sciences | 15. Environmental Science |
| 7. Biomedical & General Engineering | 16. Archaeology |
| 8. Geology | 17. Computer Science |
| 9. Medical Sciences | 18. Geography |
| | 19. Natural History & Biodiversity |

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Business - Contributing	300.00
Business - Sustaining	500.00
Patron	1000.00



VIRGINIA ACADEMY OF SCIENCE

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Phone (____) _____ E-mail _____ FAX(____) _____

Address _____

City _____ State _____ Zip _____

Institution or Business _____

Position — Title _____

Fields of Interest — Section No.(s) _____ First No. indicates major interest

Class of Membership Desired _____

Contacted by: _____

Make check payable to **Virginia Academy of Science** and send to: VAS, Science Museum of Virginia, 2500 W. Broad St., Richmond, VA 23220-2054.

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EDITOR/BUSINESS MANAGER:

James H. Martin

Dept. of Biology - PRC

J. Sargeant Reynolds Community College

P.O. Box 85622

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ABSTRACTS OF PAPERS
74th Annual Meeting of the Virginia Academy of Science
May 21-24, 1996, Virginia Commonwealth University
Richmond, Virginia

Aeronautical and Aerospace Sciences

F-18 HIGH-ALPHA RESEARCH VEHICLE MULTIAXIS THRUST VECTORING CHARACTERISTICS. Scott C. Asbury, Aerospace Engineer, NASA-Langley Research Center, Hampton, Va. 23681-0001. An investigation was conducted in the Langley 16-Foot Transonic Tunnel to determine the multiaxis thrust vectoring characteristics of the F-18 High-Alpha Research Vehicle (HARV). Thrust vectoring provides the HARV with unprecedented levels of agility at angles of attack up to 70°. NASA is conducting flight experiments with the HARV to study potential benefits of thrust vectoring for the next generation of high-performance aircraft. A wing-tip supported, partially metric, 0.10-scale, jet-effects model of an F-18 prototype aircraft was modified with hardware to simulate the thrust vectoring control system of the HARV. Testing was conducted at free-stream Mach numbers ranging from 0.30 to 0.70, at angles of attack from 0° to as high as 70°, and at nozzle pressure ratios from 1.0 to approximately 5.0. Results indicate that the thrust vectoring control system of the HARV can successfully generate multiaxis thrust vectoring forces and moments. During vectoring, resultant thrust vector angles were always less than the corresponding geometric vane deflection angle and were accompanied by large thrust losses. Significant external flow effects that were dependent on Mach number and angle of attack were noted during vectoring operation. Comparisons of the aerodynamic and propulsive control capabilities of the HARV configuration indicate that substantial gains in controllability are provided by the multiaxis thrust vectoring control system.

AERONAUTICS CONTENT PRESENTED THROUGH PROBLEM-BASED LEARNING PROMOTES THE INTEGRATION OF MATHEMATICS AND SCIENCE WITH OTHER DISCIPLINES IN ELEMENTARY AND MIDDLE SCHOOL. Bobbye Hoffman Bartels, Dept. of Math., Christopher Newport Univ., Newport News, Va. 23606. During Summer 1995, sixty elementary and middle school teachers participated in 2-week sessions as part of a Teacher Enhancement Institute. The objective of the Institute was to increase teachers' knowledge of aeronautics, problem-based learning, and technology for implementation in classrooms. NASA aeronautics researchers made presentations to teach content, tours of NASA facilities demonstrated the scientific environment of aeronautics, hands-on experiments provided classroom-useful activities, and Internet exploration of aeronautics resources incorporated technology. By the end of the Institute, teachers' knowledge of aeronautics improved significantly, in their classrooms they incorporated aeronautics through problem-based learning, and they reported a greater awareness of aeronautics in the media. Teachers observed that implementations of aeronautics through problem-based learning produced highly motivated students and an effective medium for integrating science and mathematics with the other disciplines. (Funded by NASA-Langley Res. Ctr. Office of Education)

REDUCING SEPARATION ON AIRFOILS THROUGH THE USE OF BOUNDARY LAYER CONTROL. Jeanette Farrah (Elliott), Systems Analysis Branch, NASA Langley Research Center M/S 248, Hampton, Va. 23681. Inviscid theory predicts that lift at angles of attack up to 90 degrees is possible. Viscosity, however, results in a momentum energy loss in the flow, creating a boundary layer. When there is insufficient energy in the flow to overcome the adverse pressure gradient, due to the low energy air in the boundary layer, separation occurs. By using boundary layer control (BLC), the flow can be re-energized, or the low energy air removed. This delays separation and makes the use of thick airfoils and high angles of attack practical. Early experimental results demonstrated large increases in CL_{max} as well as reductions in drag through the use of BLC on both thin and thick airfoils. A 31.5% thick BLC suction wing attached to a glider illustrated that the glider could land safely if suction failed, and that the overall drag was equivalent to a 16% thick low drag airfoil. While the major technical problem with thick airfoils is a low critical Mach number, recent research by MIT illustrated the possibility of designing a 30% thick suction airfoil with a critical Mach number of 0.65. Research needs for the future include testing new BLC suction airfoil designs as well as integrating the boundary layer control with the propulsive system of an aircraft.

A BRIEF HISTORY OF DISTRIBUTED LOAD AND LIFTING SURFACE VEHICLES. Henri D. Fuhrmann, NASA Langley Research Center, Systems Analysis Branch, Mail Stop 248, Hampton, Va. 23681-0001. An overview of the motivation for pursuing designs such as spanloaders, flying wings, and blended-wing-body type aircraft is presented in general terms. Vehicles that have the majority of their structure providing lift fall in this category. This does not limit the classification to tailless aircraft or designs that attempt to package the payload solely in the wing. The benefits of distributed loading for structural weight reduction and distributed lifting surface for aerodynamic efficiency are discussed as well as some of the pros and cons of the various configuration options. A general classification scheme for this genre of aircraft is proposed that is composed of (i) Lifting bodies, (ii) Spanloaders, (iii) Partial spanloaders, and (iv) Minimal body configurations. Several historical designs and aircraft from the early 1930's to the present are examined and discussed in light of the underlying missions and design motivations. Finally current design challenges that had not previously been considered, such as passenger pressurization of noncircular fuselages and high transonic cruise speeds, are introduced.

JOYSTICK TRACKING EFFECTS ON AUDITORY EVENT-RELATED POTENTIALS. Timothy F. Knebel, NASA Langley Research Center, Hampton, Va. 23681. Twenty-four dextral volunteers performed a tracking task across three levels of difficulty while silently counting or ignoring tones. EEG was recorded and averaged at frontal, central, and parietal electrode sites to obtain ERP components: N1, P2, N2, and P3. The amplitude of P3 was significantly diminished in the difficult tracking level compared to the easy and medium tracking levels. For the counted stimuli, P3 amplitude was larger at the central and parietal regions and N2 amplitude was greater at the frontal region. Tracking error, measured as root-mean-square error (RMSE), increased significantly from the easy tracking level to the most difficult. N2 and P3 amplitudes were significantly and negatively correlated with RMSE and P3 amplitude was negatively correlated with counting error. The results are consistent with theories of resource allocation and relevant to the development of cockpit monitoring. (This work was performed while the author held a National Research Council-NASA LaRC Research Associateship).

ACOUSTIC ANALYSIS OF A FLAP-EDGE FLOW MODEL. James E. Martin, Dept. of Mathematics, Christopher Newport Univ., Newport News, VA 23606-2998, & Jay C. Hardin*, NASA-Langley Research Center, Hampton, VA 23681-0001. Sound generated at the side edges of airfoil flaps is a very important, in some cases the most intense, source of airframe noise. Recently, Sen of the Boeing Company has proposed a new physical mechanism for the flap-edge noise source and a two-dimensional model to illustrate it. In this study, Sen's model of flap side-edge flow is analyzed to reveal its noise production potential. The flap is taken to be a slab of finite thickness in the presence of which there exists a potential flow as well as a vortex to represent the flap-edge vortex. For a particular range of the existing flow parameter, equilibrium positions of the vortex off the side edge of the flap are found to exist. The model assumes that the vortex will form near the equilibrium position. The vortex is then perturbed away from the equilibrium position by incoming turbulence causing it to oscillate and thus radiate sound. The noise field is calculated three-dimensionally by numerically integrating the Ffowcs Williams-Hawkings equation. Spectra and directivity of the farfield sound are presented. In addition, the effect of retarded time differences is evaluated.

THREE-DIMENSIONAL BOUNDARY-LAYER STATE MEASUREMENTS FROM THE 737 HIGH-LIFT WING IN FLIGHT. V. Eric Roback, NASA-Langley Research Center, Hampton, VA 23681. Flight experiments were conducted on an instrumented NASA-Langley 737-100 aircraft (TSRV) to investigate high-lift flow physics and for correlation and validation of computational and wind tunnel measurements. The possible reversion of turbulent attachment-line flow to a laminar state (relaminarization) under the action of strong favorable pressure gradients at flight Reynolds numbers has a potentially significant impact on the prediction of high-lift system performance from wind-tunnel tests and computational analyses. A combination of hot-film and pressure data, obtained from the most recent phase of the flight experiments, are reduced and analyzed for attachment-line transition and relaminarization on the slat and leading edge of the main element. Correlation parameters based on empirical wind tunnel data are used in the analysis of these flight data to predict attachment-line transition and relaminarization. Flight pressure distributions were analyzed and then processed to obtain these parameters, the attachment-line Reynolds number and the relaminarization parameter. The pressure data were correlated with hot-film data, which is in both analog and digital format. The pressure and hot-film data indicated both slat and main-element relaminarization. The flow physics observed in flight correlated well with the critical values of both the attachment-line Reynolds number and the relaminarization parameter. The knowledge that relaminarization exists in flight could significantly impact the overall high-lift design considerations of future transports.

Agriculture, Forestry and Aquaculture Science

Environmental effects on yield and agronomic traits of bean (*Phaseolus vulgaris* L.)

Elmi, Abdulkadir and T. Mebrahtu, Virginia State University, Petersburg, VA 23806.

Common bean (*Phaseolus vulgaris* L.) is a major legume consumed as a principle source of protein, vitamins, and minerals for over 500 million people in Latin America, Africa, and Asia. Bean demand is increasing with an alarming rate around the world. Bean production has to be increased to satisfy the expected demand. The objectives of this experiment were : a) To determine genotypic variations for green bean yield and dry seed yield and b) To investigate the magnitude of genotype x environment interaction effects on yield and yield components of common bean. A total of thirteen common bean genotypes were planted in four-row plots arranged in RCBD design, replicated four times in 1992, 1993, 1994, and 1995. Each genotype was evaluated for plant height, number of pods plant⁻¹, hundred pod weight, pod length and green pod yield at R7 growth stage, and number of seeds plant⁻¹, hundred seed weight, seed weight plant⁻¹, pod length, and dry seed yield at R9 growth stage. The genotype Eagle and Branco showed the highest green pod yield, while Pinto 111 and VB90-3 had the highest dry seed yield. Among the parameters measured number of pods plant⁻¹ showed the highest correlation (0.61**) to green pod yield, while number of pods plant⁻¹ ($r^2 = 0.51^{**}$) and seed size ($r^2 = 0.48^{**}$) showed the highest correlations to dry seed yield. Seed size and number of pods plant⁻¹ can be used effectively for indirect selection of green pod and dry seed yield in common beans.

PREDICTING NITROGEN STATUS OF CASTOR AND KENAF FROM CHLOROPHYLL READINGS. Angela Aikens and H.L. Bhardwaj, Agricultural Research Station, Virginia State University, Petersburg, Va 23806. Nitrogen (N) status in leaves of castor (*Ricinus communis* L.) and kenaf (*Hibiscus cannabinus* L.), two potentially new crops for Virginia, were determined by using SPAD-502, a portable chlorophyll meter. Leaves from plots of these two crops receiving 0, 50, 100, 150, and 200 kg N/ha were used for chlorophyll recording with SPAD-502 from June 29 until July 27, 1995 at 24 hour interval. Samples of leaves from these plots were also analyzed for nitrate content. Significant variation existed among 5 N levels for nitrate content in both castor and kenaf but only in castor for chlorophyll reading. The correlation between nitrate content of castor leaves and SPAD readings was highly significant (+0.66**). In kenaf, the correlation between nitrate content and SPAD reading was +0.57**. Regression analysis indicated that nitrate content of castor and kenaf leaves can be predicted from SPAD readings. These results indicate that N status of castor and kenaf can be predicted from chlorophyll readings obtained using SPAD-502. Use of SPAD-502, which costs about \$750, could be beneficial for farmers for using only the needed amount of N and may also help protect the environment from over-fertilization.

REMEDICATION OF CANINE HIP DYSPLASIA WITH VITAMIN C: ANTIDOTE AND ANECDOTE: Joseph W. Berg, Jr., PhD, 3319 Dauphine Drive, Falls Church, VA 22042
 ABSTRACT: Vitamin C (Ascorbic Acid) has been widely reputed to be beneficial in the prevention and treatment of many illnesses in vertebrates. For canines, Mueller 1996 writer and editor of Hunting Dog column in OUTDOOR LIFE magazine has documented improvement of mobility in severely disabled dogs that have been treated with Vitamin C. This is congruent with the fact that Vitamin C helps build collagen and lubricate the joints needed for mobility. Prevention and management of Canine Hip Dysplasia (CHD) has been addressed previously in terms of Genetics, Nutrition, and Exercise by Berg and van Lienden at the 1994 VAS meeting. A calcium derivative of Vitamin C now marketed under the name ESTER C[®] is found to be particularly effective probably because of the ease of absorption into the body. It is postulated also that Vitamin C can be used to prevent CHD and other joint diseases. This hypothesis has not been experimentally verified. However, it has been documented that minimal stress on puppy hips for the first year of age helps prevent CHD, regardless of Vitamin C supplementation.

NATURAL PESTICIDES FROM AGRICULTURAL CROPS. H.L. Bhardwaj, Agricultural Research Station, Virginia State University, Petersburg, VA 23806. Research conducted under a US Department of Agriculture (Office of Agricultural Materials) funded three year project has indicated that rapeseed (Brassica spp.) meal has potential for controlling *Cylindrocladium parasiticum* (Crous, Wingfield and Alfenas), casual agent of *Cylindrocladium* black rot (CBR) of peanuts and eliminating/reducing the use of Vapam, currently recommended chemical treatment. The rapeseed meal reduced the disease incidence by 7, 25, and 70% over control in 'NC6', a susceptible cultivar during 1994, when it was used as soil amendment at the rates of 1, 2, or 3 tons/ha. Similar results were also obtained from 'NC10C', a resistant cultivar. The results of experiments with soybean cyst nematode (*Heterodera glycines* Ichinohe) during 1994 and 1995 have been inconclusive. Both peanut and soybean experiments are being repeated during 1996. Detailed results of these experiments will be presented and discussed. The new crops program of Virginia State University is also evaluating castor (*Ricinus communis* L.) and lupin (*Lupinus* spp.) that contain compounds with potential pesticidal properties (ricin and alkaloids, respectively).

NEW CROP DEVELOPMENT IN VIRGINIA-A PROGRESS REPORT. H.L. Bhardwaj. Agricultural Research Station, Virginia State University, Petersburg, VA 23806. A diverse array of crop plants, including canola (*Brassica* spp.), castor (*Ricinus communis* L.), chickpea (*Cicer arietinum* L.), kenaf (*Hibiscus cannabinus* L.), lesquerella (*Lesquerella fendleri* Gray), mungbean (*Vigna radiata* L.), pigeonpea (*Cajanus cajan* L.), and vernonia (*Vernonia galamensis* Cass.), have been evaluated for production potential under Virginia conditions, under the New Crops Program of Virginia State University, established in 1991. Research during last four years has identified canola, mungbean, and kenaf as potential crops for production in Virginia. Use of canola oil is increasing steadily among health-conscious consumers due to its lowest content of saturated fatty acids. The average state canola yields during last three years yields have ranged from 1.8 to 2.1 tons/ha with highest yielding varieties yielding upto 2.7 tons/ha. Yields of kenaf, a source of pulp for paper manufacturing have been 10 to 12 tons/ha (dry matter) at about 90 to 100 days after planting. Considerable progress has been made in developing kenaf as a summer forage. Mungbean yields have averaged about 1475 to 2706 kg/ha, indicating that it can be easily produced in Virginia to eliminate annual import of about 5-7 million kg of mungbean.

FISH HEALTH STATUS OF THE AQUACULTURE INDUSTRY IN VIRGINIA. David Crosby, Cooperative Extension, Virginia State University, Petersburg, Va. 23806. The analysis of casework submitted to Va. State Univ. Aquaculture Disease Laboratory from 1993 to 1995 is reported. The laboratory processed over 150 cases during this period. The most frequently found problem were parasites. Nearly 43% of all cases (1993-1995) involved some type of fish parasite as part of the diagnosis. Trichodina, a gill and skin protozoan of fish, was the most frequently identified parasite. However, in 1993 *Ichthyophthirius multifiliis*, white spot disease (Ich), comprised nearly one quarter of the caseload. Overall, bacteria problems were involved in 27.6% of the fish health problems. The temporal grouping of casework fell into the classic fish health binomial distribution with the first peak occurring in the spring (April, May, and June) and the second peak occurring in the early fall (September and October). Catfish and hybrid striped bass were the most frequently submitted fish to the laboratory.

ASEASONAL REPRODUCTIVE PERFORMANCE OF VIRGINIA BRUSH GOATS. Michael O. Ezekwe and J. Lovin*, Ag. Res. Station, Va. State Univ., Petersburg, Va 23806. Ability to reproduce all year round in goats used for meat production will increase productivity and income for producers. A two-year study was carried out to access the potential for aseasnal reproduction in three breeds/types of goats. A total of 62 Virginia Brush (VB), 44 Nubian (N) and 46 Spanish (S) 2-3 year old does were exposed to 47-day breeding season beginning on May 20th of each year. Animals were grazed on permanent as well as summer pastures. There was significant differences ($P<.05$) for all reproductive performance characteristics studied between years, among breeds, and year x breed interactions. Spanish does did not breed during the two year trial period. Kidding rate, weaning rate, and prolificacy were 56.4, 43.6 and 85% for N, and 129.5, 118.0 and 182.5% for VB, respectively, which were significantly higher ($P<.05$) than those of the N. Litter weight at birth and at weaning did not differ ($P>.05$). Progeny ADG and weight gain between birth and weaning were unaltered. Nubian female progeny body weight was higher ($P<.05$) than those of VB counterparts at post weaning but these differences disappeared by 6 months of age. Similar trends were noted for castrates and intact males. Results indicate that VB has a potential for greater aseasnal productivity than S and N breeds. Differences in body size seem to disappear between N and VB goats raised solely on pasture for meat production.

PECTORAL SPINE LOCKING AND SOUND PRODUCTION IN THE CHANNEL CATFISH. Michael L. Fine, David McElroy, John Rafi, Charles B. King, Kathryn E. Loesser and Scott H. Newton., Virginia Commonwealth Univ., Mary Washington College, and Virginia State University. We examined the anatomical basis for sound production and locking of the pectoral spine in the pectoral girdle of the channel catfish *Ictalurus punctatus*. The locked spine is stabilized vertically by the glenoid process laterally and the dorsal and ventral processes medially. Anterior motion is halted by contact between the dorsal process and the locking foramen of the pectoral girdle, and posterior motion is prevented by the locking tubercle of the dorsal process sitting in a narrow depression at the base of the locking foramen. Pulsatile sounds, which vary in frequency, amplitude, duration and patterning, are produced when ridges on the lateroventral surface of the glenoid process contact the ventral plate of the glenoid fossa during fin abduction. We suggest that individual pulses are generated by successive contacts of a single ridge on the ventral plate of the glenoid fossa. Pulse frequency appears to be determined by the pectoral girdle, and the swimbladder does not play an active role in sound production.

A HISTOMORPHOMETRIC EVALUATION OF THE TESTIS AND EPIDIDYMIS IN THE POSTPUBERTAL SPANISH BUCK. O. M. Gaines and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. The present study evaluated age-related changes in histomorphometric testicular and epididymal characteristics of postpubertal Spanish bucks. Fifteen male goats, managed for moderate growth, were randomly allocated (n=5) to three treatment groups to be castrated at 8, 11 or 14 mo. Following castration, a portion of the testis and epididymal segments were histologically processed for histomorphometric analysis. Diameter and epithelial height from approximately 20 to 25 essentially circular cross sections of the seminiferous tubule (ST) and tubules in the ductule efferentes (DE), caput, (CA), corpus (CO) and cauda (CD) were measured. Volumetric proportions of these segments were determined from 200 test line intercepts per section. Data were analyzed for age group effects and by correlation analysis. ST diameter and epithelial height were similar between age groups and ranged from 175.4 to 179.2 μm and 50.2 to 52.0 μm , respectively. Epididymal tubular diameter was reduced ($P < .05$) in CA and CO at 11 mo (269 and 283 μm , respectively), compared to 8 mo (320 and 318 μm) and 14 mo (328 and 339 μm). Diameter of DE (343 to 392 μm) and CD (428 to 443 μm) were not affected by age. Epididymal tubular height was also not affected by age and ranged from 21 μm in the CD to 94 μm in DE. Testicular volumetric proportions were similar between age groups (tubular lumen: 11-18%; seminiferous epithelium: 63-70%; interstitial tissue: 19%). Epididymal volumetric proportions were also similar between age groups, except for a decline ($P < .05$) in extra tubular tissue in CA of 14 mo old bucks. Histomorphometric measurements were generally not significantly correlated with body and organ weights. Few age-related changes in testicular and epididymal histomorphology appear to occur in postpubertal bucks.

EFFECT OF AGE ON PARASITE BURDEN IN MEAT GOATS. T.A. Gipson, S.M. Lacey & J.C. Lovin, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. Effective control of internal parasites requires knowledge of the host-parasite interaction. In sheep, the detrimental effect of internal parasites is partially mitigated by an acquired immunity related to age. Thus, older animals are more resistant than younger animals. It has not known if goats have a corresponding age-related immunity to internal parasites. The objective of this study was to determine the relationship between age and parasite burden as determined by fecal egg counts in goats. Age of the animal was determined by dentition (0, 2, 4, 6 and 8 teeth) and ten females of each of the five age groups were randomly assigned to the sampling group. Animals used in this study were maintained as a single group on common pasture. Measurements included body weight, packed cell volume, total protein, trichostrongyle eggs per gram (epg) and coccidia oocysts per gram (opg) of feces. Fecal egg counts were determined by the Modified McMaster technique and normalized using a $\log(\text{count}+1)$ transformation. Fecal samples were cultured to identify nematode species. Data were analyzed using analysis of variance. A significant ($p < .05$) linear effect of age on bodyweight was found. Bodyweight increased linearly from 18.2 kg for 0 teeth to 53.4 kg for 8 teeth. Significant linear and quadratic effects of age on coccidia opg were also found. Coccidia opg decreased rapidly from 3764 opg for 0 teeth to 878 opg for 2 teeth and remained stable to 8 teeth (711 opg). Trichostrongyle egg counts ranged from 399 epg for 0 teeth to 775 epg for 6 teeth; however this difference was not significant. Packed cell volume ranged from 31.9% for 4 teeth to 28.4% for 2 teeth and total protein ranged from 7.0 g/dl for 2 teeth to 7.6 g/dl for 8 teeth ($p > .10$). *Haemonchus contortus* was the predominate nematode species for all age groups. This study indicates that young goats (0 teeth, which is one year of age or less) are more susceptible to coccidia than older goats. However, there does not appear to be an acquired immunity to trichostrongyle nematodes in goats.

MULTIPLE ANTHELMINTIC RESISTANCE IN GOATS RAISED FOR MEAT PRODUCTION IN VIRGINIA. T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806, A.M. Zajac*, Va. Polytechnic Inst. & State Univ., Blacksburg VA 24061 & J.C. Lovin, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. Worldwide, sheep and goat producers rely heavily on anthelmintics for parasite control. Because of this heavy use, anthelmintic resistance is developing rapidly in many countries. Recent interest in meat goat production has prompted an increased movement of breeding stock around the country, thereby increasing the risk of spreading anthelmintic resistance. Limit information on the extent of anthelmintic resistance is available in the US, especially in goats. The objective of this study was to determine if anthelmintic resistance existed in a research goat herd that had been assembled from several geographic locations. A fecal egg count reduction test was conducted using different anthelmintic popularly used by goat producers. At the start of the test, fecal samples were taken from every individual in the buck herd and half of the buck herd was dewormed with the anthelmintic being tested. The anthelmintics tested were fenbendazole, ivermectin and levamisole. The number of bucks involved in the fecal egg count reduction tests were 47 for fenbendazole, 74 for ivermectin and 34 for levamisole. Ten days post-treatment fecal samples were taken from every individual in the untreated (control) and treated groups. Fecal egg counts were determined by the Modified McMaster technique. If an anthelmintic fails to yield a 95% reduction in fecal egg counts as compared to the control group then anthelmintic resistance is concluded. Fenbendazole gave a 59.4% reduction, ivermectin a 54.0% reduction and levamisole a -4.3% reduction. Fecal egg counts actually rose after levamisole treatment. Resistance to all three of the anthelmintics tested was found in this research goat herd. Therefore, alternative methods of internal parasite control will need to be pursued in this herd of goats.

CHEMICAL COMPOSITION OF RAPESEED GREENS. A.A. Hamama and H.L. Bhardwaj, Agricultural Research Station, Virginia State University, Petersburg, VA 23806. Pre-flowering foliage from four canola and high erucic acid rapeseed (HEAR) was evaluated for chemical composition and compared to that of raw mustard and turnip greens. Canola had the highest protein content followed by mustard, HEAR and turnip. Canola, HEAR and turnip were similar in lipid content but had higher lipids than mustard. HEAR and turnip were characterized by a relatively high amount of carbohydrates and calcium as compared to canola and mustard. All four species were similar in K, Mg, P and Zn contents. Canola and HEAR had better concentration of Fe than turnip and mustard. Turnip, canola/HEAR, and mustard had the highest, intermediate, and lowest total saturated fat, respectively. For monounsaturated fatty acids, the four species can be arranged in the following descending order: mustard > HEAR > canola > turnip. Canola, HEAR and turnip were similar in total polyunsaturated fatty acid but higher than mustard. Canola and HEAR were similar in omega-3-fatty acid (18:3) content (43.0%) followed by turnip (37.2) and mustard (13.1). The results suggest that foliage of canola and HEAR (*Brassica* sp.) has potential as food/feed.

SEED AND FOLIAGE INSECT RESISTANCE IN VEGETABLE SOYBEANS. Mark E. Kraemer, Vaidra Hodges*, and Carmen Sudderth*. Virginia State University, Petersburg, VA 23806. We evaluated 12 large-seeded (green vegetable) and 10 tofu genotypes for resistance to corn earworm (CEW) defoliation and pod damage, and hemipteran seed damage. Hemipterans appeared to be responsible for much more damage than CEW and other pod feeders at our Chesterfield Co. Site. Hemipterans affect seed quality by causing aborted, discolored, or shriveled seeds, often with secondary microbial infections. Estimates of hemipteran damage ranged from 2% (Shangraowan gingsi) to 92% (Kanrich) of seeds moderately or severely damaged. Seed resistance was not correlated with foliar resistance to CEW (petri dish assays) but was positively correlated with maturity group ($P=0.0001$, $R^2=0.33$). This is probably related to hemipteran population levels during critical periods of seed development.

FETAL AGING VIA REAL TIME ULTRASONOGRAPHY IN GOAT BREEDS OF DIFFERING MATURE SIZE. S.M. Lacey and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. The use of veterinary ultrasonography finds an increasing application in livestock management. This experiment evaluated the application of transrectal and transabdominal ultrasonography in does ($n=169$), representing five breeds of varying mature size, at the end of a 40-d fall breeding season and 4 weeks thereafter. The accuracy of diagnosis was evaluated based on kidding outcome, and the indicator for diagnosis (uterine fluid, fetus or cotyledon) was recorded. Fetal dimensions were recorded as crown-rump length, and cranial length and width, wherever possible. Correlation coefficients of dimensions with fetal age were calculated. The accuracy of transrectally diagnosing open does correctly ranged from 62% at <25 d to 77% between 26-68 d of gestation, whereas the correct diagnosis of pregnant does ranged from 63% at <25 d to 96% between 26-68 d. The accuracy of transabdominal scanning of pregnant does ranged from 52% at 36-50 d and 91% at 51-68 d of gestation. The fetus was the most commonly identified structure for both transrectal (74%) and transabdominal (67%) diagnosis. Cotyledons became indicators of pregnancy after 50 d of gestation in 31% of all diagnosis. Crown-rump length increased from 1.65 cm at 21-30 d to 3.58 cm at 51-60 d and could not be measured after 61 d. Cranial width and length increased from 1.42 and 1.23 cm at 21-30 d to 2.20 and 3.63 cm at 61-70 d of gestation, respectively. Differences in fetal dimensions between breeds were not consistent. Crown-rump length ($r=.55$), cranial width ($r=.64$) and cranial length ($r=.78$) all had significant ($P<.001$) correlations with fetal age. These data indicate detection limits of 25 d for transrectal and 50 d of gestation for transabdominal modes of scanning. The findings further indicate that breed differences in fetal size appear to be limited at this early stage of gestation.

EVIDENCE OF A PERIPARTURIENT RISE OF FECAL EGG COUNTS IN A HERD OF VIRGINIA BRUSH GOATS MANAGED FOR MEAT PRODUCTION. J.C. Lovin & T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. The rise in nematode egg output around the event of parturition is well documented in sheep and is a critical control point for strategic deworming. However, it is unclear whether the periparturient rise in nematode egg output occurs in goats. Therefore, pregnant and open goats were evaluated to determine if a periparturient rise in fecal egg output occurs. Thirty-three mature female goats (19 pregnant, 14 open) made up the experimental group. A composite fecal sample (five (5) goats from each of the pregnant and open groups) was taken at two week intervals over a 20-week period that began with first doe kidding and examined for the presence of trichostrongyle eggs. Fecal egg counts were determined by Modified McMaster technique and counts were normalized by a $\log(\text{count}+1)$ transformation. Data were analyzed using analysis of variance. Fecal worm egg count means were significantly different ($P<.05$) for the pregnant and open does (1018 and 491 epg, respectively). Pregnant does were dewormed four (4) times with an average interval between dewormings of thirty-six (36) days; whereas, the open does received only two (2) dewormings with an average interval of sixty-eight (68) days. This evidence suggests that a periparturient rise in fecal trichostrongyle egg counts does exist and therefore should be an important factor in deworming strategies.

RESISTANCE TO INTERNAL PARASITES AS DETERMINED BY FECAL EGG COUNTS IN THREE "BREEDS" OF MEAT-TYPE GOATS. J.C. Lovin & T.A. Gipson, Agric. Res. Station, Va. State Univ., Petersburg, VA 23806. Control of internal parasites is the second greatest cost of goat production and therefore it is advantageous to select breeds which have a resistance to parasitism. Three breeds (Nubian, Spanish and Virginia Brush) of meat-type goats were evaluated for their resistance to internal parasites as determined by fecal worm egg counts. Sixty mature does (20 Nubian, 26 Spanish and 14 VA Brush) were managed similarly for a period of one year. A composite fecal sample (five (5) does from each breed) was taken every two weeks and examined for the presence of trichostrongyle eggs. Fecal egg counts were determined by Modified McMaster technique and counts were normalized by a $\log(\text{count}+1)$ transformation. Data were analyzed using analysis of variance. Fecal egg count means for the VA Brush does were significantly ($P<.01$) lower (390 epg) than the Spanish (785 epg) or Nubian (900 epg) does. Number of dewormings for the Nubian, Spanish and VA Brush does was 12, 9 and 6, respectively, translating into a significant difference ($P<.05$) in the average interval between dewormings of 33.7 and 67.8 days for the Nubian and VA Brush does, respectively. From these findings, estimated annual deworming costs for this herd were \$13.08, \$7.29 and \$5.16 per head, respectively, for the Nubian, Spanish and VA Brush does. This evidence suggests that VA Brush does are more resistant to internal parasites than Spanish or Nubian and that deworming costs can be reduced by selecting for resistant breed types.

DOMESTICATION AND NUTRITIONAL EVALUATION OF PURSLANE. Tadesse Mebrahtu, Michael Ezkewe*, Thomas Omara-Alwala*, Abdulkadir Elmi*, Agric. Res. Stat. VA State Univ. Petersburg 23806. A total of eleven purslane accessions received from different geographical locations were planted for agronomic and nutritional characterizations. Each accession was planted at two planting dates arranged in a split-plot design during three growing seasons. Significant differences ($P < 0.05$) for Protein, total lipid, carbohydrate, linolenic (18:3)/linoleic (18:2) fatty acid ratio, and fresh yield were observed among accessions tested. Similarly, significant accession \times planting date interactions were observed for all traits measured. Among the accessions tested, *Portulaca oleracea* and Garden Dutch showed consistently the highest fresh yield throughout the growing seasons. Linolenic acid was the most abundant fatty acid in purslane leaf tissue. This resulted in, an overall average of 18:3/18:2 a fatty acid ratio of 7.1% which is more superior nutritively than that of many essential oil crops such as perilla (*Perilla trutescens*) and soybean (*Glycine max* L.). The average total protein content of purslane crop was 24 % which is higher than alfalfa. Wide range of variability existed among the accessions tested for selection and genetic improvement through hybridization.

EFFECTS OF MICROWAVE HEATING ON THE QUALITY OF VERNONIA OIL. A. I. Mohamed, C. Paul*, Agricultural Research Station, Virginia State University, Petersburg, VA 23806 & R.L. Grayson*, Depart. of Plant Pathology, Virginia Tech., Blacksburg, VA 2406. Epoxy fatty acids and epoxy oil are useful raw materials for manufacturing paints, coatings with low or no volatile organic compounds, and many other products. Currently, no oilseed crop has been commercialized as a source of natural epoxidized oils. Vernonia galamensis is an ideal candidate to be domesticated to meet the need for epoxy oil. This study was conducted to determine the effects of microwave heating on the physical and chemical characteristics of vernonia oil. Whole vernonia seeds were microwave heated at 1000 watts for 0, 10, 20, 40, 60, 80, 100, 120, 140, and 160 Sec./5g seed at 8 and 15% moisture. In another experiment vernonia seeds were microwave heated for 80 Sec. at 0, 20, 40, 60, 80, and 100 watts. No significant change ($P > 0.1$) was found in oil content, vernolic acid, epoxy content, oxirane o, %, and weight per epoxy equivalent at 8% moisture. However, increasing moisture to 15% caused a small but significant ($P > 0.05$) reduction in vernolic acid and epoxy content and a significant increase ($P > 0.05$) in the amount of extracted oil. Microwave heating of pure vernonia oil caused a small increase in the total free fatty acid. Increasing microwave heating time was associated with an increase in vernolic acid % in the free fatty acid pool. As a conclusion, microwave heating can be used as an economical method for inactivating lipase in vernonia seeds with minimum or no deteriorating effect of the oil.

EVALUATION OF SOYBEAN GENOTYPES FOR TOFU QUALITY AND QUANTITY. A.I. Mohamed, Paul, Agricultural Research Station, Virginia State University, Petersburg, VA 23806 & V.T. Spara*, Alabama A&M University, Normal, AL 35762. Most soyfood processors recognized that to make a high quality tofu, a high quality soybean must be used. At this point, producers and breeders have failed to identify these ideal soybean varieties. The objective of this study was to determine the influence of variety and environmental factors on yield and chemical composition of tofu. A total of 12 Soybean genotypes were used. Proximate analysis were carried out using standard AOAC methods. Soymilk and tofu were manufactured using the traditional method. There were significant differences between cultivars for all tested parameters. Soybean genotypes with high oil were lower in protein content as reported in our earlier studies. Tofu yield ranged from 75 for Barc-8 to 52 g/100 g seed for V71-370. A positive and significant correlation was found between seed protein content and tofu yield. Genotypes Ernei and V71-370 had significantly lower yield than the other genotypes. Barc-8 and Barc-9 had the highest resistance pressure with Shear Force of 44 and 33 lb., respectively indicating least tender tofu, while V71-370 was most tender (18.9). Fiber content ranged from 4.1 to 5.1%. Data also indicated that genotypes with lower fiber content had a higher swell ratio. (this research is a group efforts and is a part of RR7 regional Project funded by CSREES/USDA).

PRELIMINARY EVALUATION OF CAGE CULTURE OF BROOK TROUT IN VIRGINIA. Scott H. Newton, Cooperative Extension, Virginia State University, Petersburg, Va. 23806. Brook trout (*Salvelinus fontinalis*) was designated as the State Fish by the 1993 Virginia General Assembly. Brook trout is the only species of freshwater trout native to the Commonwealth. They are raised primarily for stream stocking and fee-fishing operations. Because they command a higher price than rainbow trout, both as juvenile and adult fish, they may have aquaculture potential for cage operations located in the Piedmont Region. Three cages were each stocked with 250 brook trout averaging 3.5 ounces on November 2, 1995 and harvested April 23, 1996. Fish survival was 93% overall and the trout averaged over 9 ounces at harvest. Although growth was less than expected, most of the first year culture difficulties were associated with a colder than normal winter production season. Based upon first season observations, brook trout appears to be a good candidate for commercial cage production during the winter season; however, further research is warranted before specific recommendations can be provided to producers.

THE VIRGINIA AQUACULTURE PLAN - A SYNOPSIS. Scott H. Newton, Cooperative Extension, Virginia State University, Petersburg, Va. 23806. The Virginia Aquaculture Plan consists of two documents. ***The Executive Summary and Recommendations*** outlines principal industry concerns and gives recommendations for changes. This document also provides industry overviews, production status for marine and freshwater operations, business opportunities and related information. ***A Guide to Aquaculture Development and Industry Information*** provides material on industry opportunities, resource contacts, economics, marketing and financial aspects, production potentials, and regulatory requirements for commercial aquaculture. The Virginia Aquaculture Plan was compiled and written over a two year period, (1993 - 1995) and involved industry, government, support organizations, and the scientific community. The Plan was supported and printed by the Virginia Department of Agriculture and Consumer Services. Distribution began during early 1996 and copies of The Plan are available free to those interested in commercial aquaculture ventures from the Virginia Department of Agriculture and Consumer Services, Richmond, Virginia.

EVALUATION OF MINT GERMPLASM UNDER VIRGINIA CONDITIONS. M. RANGAPPA, H.L. Bhardwaj, and M. Showhda. Agricultural Research Station, Virginia State University, Petersburg, Va 23806. A collection of 35 mint (*Mentha* spp.) lines, received from US Department of Agriculture in 1992, was evaluated for chemical composition during summer of 1993 to study suitability for culinary use or oil extraction. These lines were categorized based on geographic origin (domestic vs. Foreign), ploidy level (diploid vs. Polyploid), mint type (peppermint vs. spearmint), and genetic makeup (pure lines vs. hybrids). Leaf moisture was affected by the genetic makeup, pure lines had lower moisture content (71%) as compared to hybrids (73%). The ash content was affected by the geographic origin, the ploidy level, type of mint, and genetic makeup of mint lines. The ash content of domestic lines was lower (10%) than that of foreign lines (10.7%), diploid lines had higher ash content (10.8%) as compared to polyploids (10.0%), peppermint types had lower ash content (10.0%) than spearmint lines (10.6%), and pure lines had higher ash content (10.4%) than hybrids (10.0%). The content of essential oils was higher in diploid lines (2.1%) as compared to polyploid lines (1.6%) indicating that diploid lines may be more suitable for oil extraction.

CHINESE WATER CHESTNUTS, A POTENTIAL NEW CROP FOR VIRGINIA. David Wainwright* and A.J. Provenzano. Dept. of Ocean., Old Dominion Univ., Norfolk, Va. 23529. Currently no Chinese water chestnuts (*Eleocharis dulcis*) are grown commercially within the United States. Available supplies are grown in Asian countries and imported. Methods for growing Chinese water chestnuts in the United States have been established through a limited number of experiments conducted throughout the past 50 years. Using these established methods, a preliminary crop of Chinese water chestnuts was grown in a shallow lined pond in Surry County, Va. The purpose of this study was to determine the feasibility of possibly establishing a new alternative crop for Virginia's Eastern Shore, as well as in other places along the southern portion of the eastern seaboard. Results showed an average of more than 15,000 kg/ha and an average corm size of 10.8 g. Furthermore, 75% of the yield is considered marketable. Our study also included a salinity tolerance experiment. Results from this experiment showed that Chinese water chestnuts are restricted to fresh water.

TESTICULAR AND EPIDIDYMAL SPERM RESERVES AND HISTOMORPHOLOGY IN MATURE SPANISH GOATS. O. M. Gaines and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. This study determined sperm reserves and quantitative histomorphology of testis and epididymis in mature, sexually rested, Spanish bucks ($n=6$) castrated during the breeding season. The right testis and epididymis were processed for the determination of sperm numbers by tissue homogenization and hemocytometer count, whereas the left testis and epididymis were fixed, sectioned and stained (H&E) for quantitative histology. Means and standard errors, and correlation coefficients of live animal measurements (body weight and scrotal circumference) with reproductive tract characteristics were determined. Body weight, scrotal circumference and paired testicular weight were 46 ± 4.6 kg, 26 ± 0.3 cm and 227 ± 11 g, respectively. Paired epididymal weight was 42 ± 0.8 g, with caput, corpus and cauda representing 50, 9 and 41% of the total weight, respectively. Sperm production (elongated spermatids and spermatozoa)/g testicular parenchyma was $92 \pm 5.5 \times 10^6$ and total testicular reserve $20.1 \pm 1.7 \times 10^9$. Epididymal sperm reserves were $54 \pm 2 \times 10^9$, with cauda reserves, the site of sperm storage, representing 67% of this reserve. Seminiferous tubule diameter and epithelial height were 212 ± 2.7 μ m and 62 ± 2.3 μ m, respectively. Epididymal tubule diameter and epithelial height ranged from 339 ± 18 (corpus) to 470 ± 16 μ m (d. efferentes) and 27 ± 3 (cauda) to 124 ± 6 μ m (d. efferentes), respectively. Body weight was correlated with sperm production rate ($r=.84$; $P<.05$) and seminiferous tubule diameter ($r=.89$; $P<.01$), whereas scrotal circumference was correlated with testis weight ($r=.90$; $P<.01$) and testicular reserve ($r=.79$; $P<.05$). These data demonstrate similar reproductive characteristics in meat-type bucks to those reported for fiber bucks.

KIDDING PERFORMANCE OF PYGMY GOATS IN A VIRGINIA HERD. S. Wildeus¹, S. Waters^{*2} and M. Waters^{*2}, ¹Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806 and ²Daisy Hill Pygmy Goats, Callaway, VA 24067. Pygmy goats have been widely used as pets or show animals in the U.S., but their potential for meat goat production has not been well defined, though their origin and conformation is that of a meat type animal. This study summarizes records collected in a commercial herd over a 14 year period (1980-1993), and included 130 doe and 224 kid records, representing 37 dams and 18 sires. Animals were managed on a forage base (pasture or high quality hay), with concentrate supplied according to stage of production. Standard herd health practices (deworming, vaccination) were performed on routine basis. Does were hand-mated to kid in spring. Observations recorded included dam and sire identification, litter size, kid birth weight and time of birth. Doe data were analyzed for effects of dam, sire, parity and litter size; kid data were analyzed for effects of dam, sire, birth type and sex of kid effects. Overall litter size and litter weight were 1.75 kids and 2.25 kg/doe kidding, respectively, and both increased ($P<0.05$) from first to third parturition. Single litters were lighter (1.63 kg) than twin (2.69 kg) and triplet (2.40 kg) litters ($P<0.05$), whereas quadruplet litters (4.54 kg) were heaviest ($P<0.005$). Dam had a significant effect on litter size ($P<0.01$), but not litter weight, while sire had no effect. Single born kids were heavier ($P<0.001$) than multiple born kids (1.35 kg), but there was no effect of sex on kid birth weight. Both dam and sire had an effect ($P<0.01$) on kid birth weight. Kidding occurred predominantly between 10 AM and 5 PM (60% of potential kiddings). These data confirm the Pygmy as a prolific breed under temperate production conditions, but additional data are needed on the growth performance of the breed in relation to mature size.

BLOOD METABOLITE CONCENTRATIONS IN MEAT-TYPE GOAT BREEDS AT THREE STAGES OF LACTATION. M. A. Wright and S. Wildeus, Agricultural Res. Station, Va. State Univ., Petersburg, Va. 23806. Limited information is available on the comparative performance of meat-type goat breeds and the underlying physiological differences. This experiment evaluated the blood metabolite concentrations of Myotonic (n=12), Pygmy (n=10) and Spanish (n=22) does at parturition, peak lactation (21 d) and weaning (63 d). All does were managed as one group and fed a medium quality, high forage diet. Plasma urea nitrogen, total protein and glucose, and hematocrit were determined in jugular vein samples. Data were analyzed by repeated measures analysis and correlation analysis. Doe body weight was higher ($P < .01$) in Spanish (34.3 kg) than in Pygmy does (17.4 kg), with Myotonic does (30.0 kg) being intermediate, but body weight was not affected by stage of lactation. Plasma urea nitrogen concentrations were higher ($P < .001$) at weaning (19.3 mg/dl) than at the earlier stages of lactation (8.5 - 11.9 mg/dl), and showed a breed x stage of lactation interaction ($P < .01$), with Pygmy does having lower concentrations at parturition and peak lactation, but higher values at weaning, than the other two breeds. Plasma total protein increased ($P < .001$) from 5.54 g/dl at parturition to 11.1 g/dl at weaning, but was not affected by breed. It was positively correlated with doe lactation weight change ($r = .511$; $P < .01$) and negatively with litter pre-weaning average daily gain ($r = .588$; $P < .001$). Plasma glucose was lower ($P < .05$) in Spanish (3.42 mg/dl) than in Myotonic (3.99 mg/dl) and Pygmy does (4.12 mg/dl), but not affected by stage of lactation. In contrast, hematocrit was similar between breeds, but declined from 21.1% at parturition to 17.6% at weaning. These data suggest that nutritional status, expressed as plasma total protein and urea nitrogen, is more affected by stage of lactation than breed in meat-type goats.

Archaeology

MANDIBULAR TOOTH WEAR AND PIG MANDIBLES: FINDING THE HUSBANDRY IN TEETH. Ethel Wu, Dept. of Archaeological Res., Colonial Williamsburg Fndn., Williamsburg, Va. 23187-8795. Tooth wear analysis may determine the approximate age of death of a certain animal with more accuracy and precision than the more commonly used method of long bone analysis. The accuracy of long bone analysis depends heavily upon the extent of dog chewing in an assemblage. For this reason, it is believed that the youngest age group in the total population will be underestimated. To test the extent of error of the ages based on fusion, two methods of tooth wear analysis are employed to determine the ages of pig mandibles from two colonial sites in the Chesapeake. The Annie Grant method allows for a detailed relative ages, while on the other hand, the Gail Bull & Sebastian Payne method provides the approximate real ages needed for the comparison of the long bone data. Together, these methods will not only test the validity of long bone analysis, but because they provide different perspectives on the data, they combine to make the data more accurate.

THE RISE AND FALL OF GLOUCESTER TOWN: AN HISTORICAL AND ARCHAEOLOGICAL PERSPECTIVE. Kenneth E. Stuck, Center for Archaeological Research, College of William and Mary, Williamsburg, Va. 23187. Gloucester Town, located on Gloucester Point, is among the earliest towns in Virginia. It was archaeologically investigated in the late 1970s and early 1980s by the Virginia Research Center for Archaeology. These emergency salvage excavations identified structures and recovered artifacts from Gloucester Town's three-hundred-year history, resulting in the placement of the Gloucester Point Archaeological District on the National Register of Historic Places in 1985. Since 1988, the William and Mary Center for Archaeological Research has conducted 20 projects on Gloucester Point that have recovered extensive evidence of the town's development. This paper presents a comprehensive look at Gloucester Town. Using the archaeological evidence to support the historic documents, the paper discusses the formation of the town, its growth and decline, and its eventual disappearance.

WATSONS, WILLIS, AND DEDAKERS: THE EVOLUTION OF A NINETEENTH CENTURY FARMSTEAD IN PIEDMONT VIRGINIA. Stevan C. Pullins, Ctr. for Archaeological Res., Dept. of Anthropology, Col. of William and Mary, P.O. Box 8795, Williamsburg, Va. 23187-8795. The physical evolution of an Amherst County farm over 130 years reflects the lives of two families in the nineteenth century and changing socio-economic and settlement patterns before and after the Civil War.

HIGH-TECH ARCHAEOLOGY ON A SHOESTRING BUDGET: EVALUATION OF SOIL RESISTIVITY TESTING AT MONTPELIER. Scott K. Parker, Montpelier Archaeologist, National Trust for Historic Preservation, Montpelier, P.O. Box 67, Montpelier Station, VA 22957. Soil resistivity survey, while not a new technique, has proven to be an inexpensive and efficient means of discerning sub-surface patterns with a minimum of site impact. Testing by National Trust for Historic Preservation archaeologists began in the spring of 1992, and has been accomplished using a "home made" soil resistivity meter, developed by a Montpelier volunteer. This paper will discuss the results of ongoing soil resistivity testing at Montpelier, home of President James Madison. The paper will explore soil resistivity in general, aspects and specifics of Montpelier's meter, and the results from several sites tested including an early 18th-century cemetery, 18th - 19th century domestic sites, and an 18th-century industrial ironworks site.

THE SAUGUS IRON WORKS RESTORATION: A COLD WAR LEGACY. Donald W. Linebaugh, Center for Archaeological Research, College of William and Mary, Williamsburg, Va. 23187. Following his discovery of Thoreau's cabin at Walden Pond in 1946, Roland Robbins performed pioneering work at a series of important sites, the Saugus Iron Works in Saugus, Massachusetts, the Jefferson birthplace in Virginia, and the Philipsburg Manor Upper Mills in Tarrytown, New York. Robbins worked for preservation organizations that were engaged in developing and enhancing their properties through historical restoration, reconstruction, or monument building. The postwar period was an age of anxiety, "a time when concerns about national security, swift social change, and a profound sense of historical discontinuity troubled people deeply." Historical museums and sites around the country reacted to this growing angst and began to market themselves as sources of patriotic inspiration, national pride, and as keepers of the legends of early America. The Saugus Iron Works restoration, for example, was underwritten by the American Iron and Steel Institute as a symbol of the industry's important contribution to the past and present growth of the country. In this context, the Saugus project was wedged between the tradition-oriented, antimodern values of the early preservation movement and a burgeoning commercial utilization of the past. This so called "Corporate Roots movement" had its own agenda that was frequently at odds with the goals and desires of preservation professionals. This paper examines the Saugus Iron Works project and Robbins's developing career within this broader historical context.

FINGERPRINT ANALYSIS OF POTTERY SHERDS AS A POTENTIAL SOURCE OF INFORMATION FOR THE HISTORICAL ARCHAEOLOGIST. Emily D. Johnson, Mark A. Fashing*, Dept. of Archaeology, Colonial Williamsburg Foundation, Williamsburg, Va. 23185. Fingerprints are common to all mankind, yet unique to each individual. Fingerprints left by a colonial potter during production can yield data concerning trade distribution, and information relating to seventeenth-century pottery production. In order to successfully use the information provided by these impressions, it is necessary to find a suitable method of comparing fingerprints. Ideally this method would meet three criteria. It must be cost-efficient, nondestructive, and yield an accurate reproduction of the impressed print suitable for analysis. In view of these criteria, several methods were tested using the pottery sherds found at the Challis site on the banks of the James River. Three methods have proved acceptable and may provide future studies with the key to more extensive analysis.

"THOSE ABOMINATIONS, THOSE BREEDER'S OF DISEASE": THE ARCHAEOLOGY OF CIVIL WAR SIBLEY TENTS AT GLOUCESTER POINT, VIRGINIA. Thomas F. Higgins III, Center for Archaeological Research, College of William and Mary, Williamsburg, Va. 23187. The Civil War soldiers' ability to adapt to a range of conditions, as expressed in the types of shelters in which they lived has resulted in a diverse archaeological record. The excavation of portions of Site 44GL358 for the Coleman Bridge Project in Gloucester County, Virginia, provided the WMCAR the opportunity to document Civil War structures associated with a Federal army camp at Gloucester Point. The camp site, dating to the period 1862-1865, was probably occupied by either Massachusetts or upstate New York troops. Site 44GL358 revealed the remains of palisade-walled Sibley tents or "Bell Tents" as they were also called. Although soldiers' generally disliked Sibley tents due to cramped conditions, the archaeology suggests that attempts were made to make the tents at Gloucester Point more comfortable. The Sibley tents found at Site 44GL358 contain the remains of unique heating systems known as "California Furnaces." These furnaces consisted of an underground air hole, i.e., flue, that extended from a stove to the exterior of the tent. The California furnace has been attributed to some Massachusetts troops, but was probably used by other troops as well early in the war.

A KAOLIN PIPE STEM SERIATION OF THE CLAY BARROW PIT AT RICH NECK PLANTATION. Richard Grant Gilmore, III, The College of William & Mary in Virginia, Williamsburg, VA 23185-4044. Imported English kaolin pipe stems are used to seriate a clay barrow pit at a seventeenth century plantation established by the Ludwell family in James City County, Virginia. Using this dating technique it can be determined that the pit was filled over a lengthy period of time. Seriation can be used to determine a relative sequence for context deposition. Contexts not in physical proximity to each other are shown to be related temporally. Bi-modal deposition is observed in early layers. Adequate sample size is indicated through "battle ship curves" in data plotting. Pipe stem seriation of this barrow pit is able to address each of these questions where alternate artifacts are not able to provide the desired information. (Research data generously provided by the Colonial Williamsburg Foundation, Department of Archaeological Research.)

THE E³ FORMULA FOR THE PRESENCE AND ABSENCE OF DOMESTIC FAUNA IN ARCHAEOLOGICAL SITES. Jeremiah R. Dandoy, Norfolk, VA 23517. I believe there are only three factors which account for the presence or the absence of non-pet domesticates in any archaeological site. These are the Ecology of the area, the Economics of any associated hominid population, and the Ethos of any associated hominid population. When these three are incorporated into a binary equation with a presence or absence outcome, and then correlated with a locus type, a focus is provided for a more far reaching analysis of faunal richness and diversity as they relate to hominid preference and activity patterns. Taphonomic and recovery biases, of course, enter into the analysis but are a given for this paper. The equations number 16 with 8 being equalities and 8 being inequalities. Seven of the equalities result in an absence marker. Seven of the inequalities result in a presence marker. The equations force us to think more about how and why fauna were used and the role of competing species. I have found this approach useful to better understand why goats are virtually non-existent in early 17th Century Chesapeake sites, seemingly disputing the extant documentation for that time. Greater cultural understanding may unfold by incorporating this methodology into our faunal interpretation

Astronomy, Mathematics and Physics

ON THE SECULAR ACCELERATIONS OF THE ORBITS OF IO, EUROPA, GANYMEDE, AND CALLISTO. Kenneth C. Jacobs, Dept. of Physics, Hollins Col., Roanoke, Va. 24020. In collaboration with Samuel J. Goldstein, Jr. (Dept. of Astronomy, Univ. of Va.), we seek the effects of tidal torques on the secular accelerations of the orbits of the four large Jovian moons. We consider the fully-coupled satellite system, and set up five linear equations – conservation of energy and angular momentum, the Laplace law, and data from Sampson (1910) and Lieske (1980) – to determine the time derivatives of the mean motions of the four moons. In units of 10^{-10} yr^{-1} , the results are: $\dot{n}_1/n_1 = 3.54 \pm 0.56$, $\dot{n}_2/n_2 = 2.78 \pm 0.11$, $\dot{n}_3/n_3 = 1.23 \pm 0.91$, and $\dot{n}_4/n_4 = -3.12 \pm 0.85$. The effective torque on Io is: $(-5.1 \pm 4.6) \times 10^{24} \text{ dyne-cm}$; this torque opposing Io's orbital motion is consistent with zero! This talk will clarify our results, and will exhibit the algebraic sensitivity of our five linear equations. (Supported in part by a Faculty Travel Grant from Hollins College.)

THE USE OF AN INTERACTIVE CLASSROOM AS AN EARLY WARNING SYSTEM FOR STUDENTS WITH DIFFICULTIES. Frederick F. Hartline, Dept. of Physics & Computer Science & George R. Webb, College of Science & Commerce, Christopher Newport University, Newport News, Va. 23606. Student motivation and participation in class is greatly increased by the use of a classroom communication system (CCS) consisting of a network, numerous palm-top computers that students share in small groups, and an instructor's desktop computer with projection capability. This system allows students to electronically answer questions from their seats, and stores, categorizes, and displays analyses of these answers on cue for the instructor and class to share. The daily use of such a CCS provides a detailed electronic record of student attendance, participation, and overall success in answering questions that are directly related to the course objectives. We have correlated CCS acquired student performance data with customary indicators of performance (mid-semester tests, exam and course grades) over four semesters in a 90 to 140 student introductory physics course for non-majors at Christopher Newport University. Our analyses suggest that CCS acquired data readily identifies students who are experiencing difficulty in the course. Since these indicators are gathered automatically and are continuously updated, it may be appropriate to use them to trigger interventions designed to increase student retention and success in the course.

TESTING OF PHOTOMULTIPLIER TUBES FOR THE CEBAF LARGE ACCEPTANCE SPECTROMETER. Robert Atkins and Dr. Kevin Giovanetti, Department of Physics, James Madison University, Harrisonburg, Va. 22807. Photomultiplier tubes are being tested at James Madison University for future use in the Electromagnetic Calorimeter of CEBAF's large acceptance spectrometer. These tubes are being characterized by dark current and linearity. Methods and results will be presented.

COMPRESSION OF ELECTROCARDIOGRAM DATA: AN IMPROVED WAVELET BASED SCHEME. Brian Bradie, Dept. of Mathematics, Christopher Newport Univ., Newport News, VA 23606-2998. Several modifications have been made to a wavelet packet based compression scheme for single lead electrocardiogram (ECG) data. First, digital filters were implemented to remove powerline interference and to attenuate high-frequency muscle noise prior to compression. By localizing signal variance around the structural components of the ECG, noise filtering produced better than a 9% reduction in data rate, together with a 13.5% reduction in root mean-square (rms) error in the reconstructed signals. Next, linear prediction and an adaptive arithmetic coder were used to improve the coding of compressor output. The improved coding strategies produced an additional 17% reduction in average data rate; since all techniques were lossless, there was no effect on rms error. Finally, separate average vectors were maintained for the dominant and non-dominant beat types occurring in a given signal to account for morphological changes in the QRS complex. A significant reduction in coefficient data rate was anticipated; however, for the test cases used in this study, a slight increase in coefficient data rate was produced.

Development of a Calibration System for CEBAF's Large Acceptance Spectrometer. Darren Ellis, Dr. Kevin Giovanetti, Department of Physics, James Madison University, Harrisonburg, Va. 22807. The forward EMC of the CLAS detector will require routine calibration. Development and installation of a photomultiplier tube calibration system to perform this operation is currently being performed by our group at JMU. An overview of the design and implementation of our calibration system will be presented.

THE DESIGN AND DEVELOPMENT OF A PROCESSOR FARM FOR ANALYZING A LARGE VOLUME OF EXPERIMENTAL DATA. David L. Hibler, Department of Physics & Computer Science, Christopher Newport Univ., 50 Shoe Lane, Newport News, VA 23606. The Continuous Electron Beam Accelerator Facility (CEBAF) will generate experimental data at a rate of roughly one terabyte per day. This corresponds to a sustained rate of about ten megabytes per second and is approximately ten times the data collection rate at other national accelerator laboratories. Basic data analysis must keep up with the accumulation of raw data. In order to do this, a processor farm is being built. Raw data files will be stored in a tape silo. The data will then be sent to a collection of approximately forty workstations for processing. These workstations will be connected to an ATM network. The software which manages the processor farm is being designed in an object oriented fashion although the implementation will not be in an object oriented language. The farm will operate in a coarse-grained parallel mode (CPM) instead of a fine-grained mode. This talk discusses both the hardware and the software design for the CEBAF processor farm.

GUI INTERFACES USING TCL/TK TO CONTROL A PHOTOMULTIPLIER TUBE CALIBRATION SYSTEM FOR CEBAF'S CLAS DETECTOR. Walter Opaska and Dr. K.L. Giovanetti, Dept. of Physics, James Madison University, Harrisonburg VA 22807. A graphical interface is being designed as an input and status display for control of a calibration system. This interface will be built using TCL/TK a script language developed to facilitate the development of windows with nice graphical features. This system must have the added capability that it can be run over a network. An overview of the control problems and their solution using TCL/TK will be given.

OPTICAL PROPERTIES OF LITHOGRAPHICALLY FABRICATED SEMICONDUCTOR NANOSTRUCTURES. Peter A. Knipp, Dept. of Physics and Comp. Sci., Christopher Newport Univ., Newport News, VA 23606, & T. L. Reinecke, Naval Research Lab., Washington, DC 20375. Experimentalists at the University of Würzburg (Germany) have the ability to fabricate quantum wires and dots of lateral dimensions 25 nm - 200 nm by patterning 5 nm thick semiconductor quantum wells. In subsequent experiments, photoexcited carriers are confined laterally in quasi-one-dimensional or quasi-zero-dimensional states by the modified potential barrier. We have made detailed numerical calculations of the laterally quantized electron and hole states and of the optical transitions for these systems, including also the presence of a uniform magnetic field. Blueshifts seen in recent photoluminescence experiments agree quite well with our calculated results, which are free of any tunable parameters and which use the nanostructure sizes obtained directly from scanning electron microscopy images. This agreement indicates that there are effectively no optically inactive dead layers in these structures. (Supported in part by the U. S. Office of Naval Research and by the Office of International Studies at Christopher Newport University.)

Developing Instructional Scanning Tunneling Microscopy for Surface and Biological Studies in Undergraduate Research. K. Daniel Phillips and Gerald R. Taylor, Jr., Physics Department, James Madison University, Harrisonburg, VA 22807.

The Scanning Tunneling Microscope (STM) is a powerful tool for visualizing molecules and surfaces at the atomic level. It has been used by others to examine metals, semiconductors, and organic molecules. In this paper, we describe methods of vibration isolation using a stacked-plate elastomer system and review STM techniques. Atomic resolution of highly oriented pyrolytic graphite is employed as an excellent surface material for instructional scanning tunneling microscopy. Finally, we show that uncoated *E. coli* DNA adsorbed onto highly oriented pyrolytic graphite can be imaged to show the helical nature of DNA, including elucidation of the major and minor grooves. This work illustrates the wide array of applications of scanning tunneling microscopy for surface sampling and molecular biological research.

PHOTOMULTIPLIER TUBES AND THEIR APPLICATIONS TO A CALIBRATION SYSTEM FOR THE CLAS DETECTOR AT CEBAF. Justin Voshell and Dr. Kevin Giovanetti, Department of Physics, James Madison University, Harrisonburg, Va. 22807. Photomultiplier tubes are key to the operation of the CLAS detector in Hall B at CEBAF. The operation of these tubes will be discussed as well as their role in the detector.

Exploring the Atomic Structure of Graphite With X-ray Diffraction and Scanning Tunneling Microscopy. Michael D. Purdy and Gerald R. Taylor, Jr., Physics Department, James Madison University, Harrisonburg, VA 22807.

Application of STM (scanning tunneling microscopy) and x-ray diffraction were used to reveal the atomic configuration and spacing of pyrolytic graphite in an undergraduate laboratory project. The configuration and spacing of atoms in the crystal structure of pyrolytic graphite were measured using an instructional STM. The sample was then mounted in a TEL-X-Ometer X-ray diffraction apparatus to determine the distance between the weakly bonded planes. Graphite data and problems associated with set-ups, vibration, and humidity will be presented.

Biology

EFFECTS OF DEPLETION OF MACROPHAGES BY DESULFATED IOTA CARRAGEENAN INJECTION ON INDUCTION OF RESORPTION BY LIPOPOLYSACCHARIDE INJECTION IN CD-1 MICE. C. A. Aurentz and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va., 23005, and C. M. Conway, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284-2012. Pregnant CD-1 mice were injected intraperitoneally with 3 mg of desulfated iota-carrageenan in phosphate-buffered saline on days 4, 6, and 8 of gestation in order to deplete active macrophages. Control mice were injected intraperitoneally with 0.5 ml of phosphate-buffered saline on days 4, 6, and 8 of gestation. Resorptions were induced by intravenous or intraperitoneal injection of 5 μ g of lipopolysaccharide in sterile phosphate-buffered saline on day 9 of gestation. Females were euthanized on day 12 of gestation and evaluated. Injections of desulfated iota-carrageenan had no significant effect on the frequency of resorptions induced by intravenous or intraperitoneal injections of lipopolysaccharide. If the desulfated iota-carrageenan injections did effectively eliminate macrophages, then active macrophages were not essential to the lipopolysaccharide-induced resorption process.

EFFECTS OF ESTRADIOL 17-BETA ON PHENYLETHANOLAMINE N-METHYLTRANSFERASE AS MEASURED BY WESTERN BLOTTING. Laura M. Kim & Jennifer K. Stewart, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284. The goal of this research project was to determine the effect of estradiol 17-beta, a potent estrogen, on the electrophoretic pattern of phenylethanolamine N-methyltransferase (PNMT) protein extracted from the adrenal glands of male rats. Total tissue protein was determined with the Lowry assay. Proteins were separated by molecular weight with SDS-polyacrylamide gel electrophoresis (SDS-PAGE) and by both molecular weight and charge with native polyacrylamide gel electrophoresis. Western blotting, in which an antibody is used to detect a specific protein, was used to visualize the electrophoretic pattern of PNMT protein. No changes were observed in the electrophoretic pattern of PNMT protein separated by SDS-PAGE. However, after separation of proteins on native gels, a different charge form of PNMT was observed in adrenals of rats treated with estradiol 17-beta. This change in charge was associated with low PNMT activity. These findings suggest a new mechanism for modulating PNMT.

COMPARISON OF RESORPTION FREQUENCIES INDUCED IN CD-1 MICE BY INTRAVENOUS INJECTIONS OF INTACT LIPOPOLYSACCHARIDE, DETOXIFIED LIPOPOLYSACCHARIDE, AND LIPID A FROM *ESCHERICHIA COLI* 055:B5 AND *SALMONELLA TYPHIMURIUM*. J. T. Kohler, J. M. Lively, and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va. 23005 and C. M. Conway, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284-2012. The effects of injection of lipopolysaccharide (LPS) from *Escherichia coli* O55:B5 and from *Salmonella typhimurium* were studied in pregnant CD-1 mice. Intravascular injection of 5 μ g of LPS from either bacterium on day 9 of gestation increased resorption significantly (from 10% to 100% for *E. coli* LPS and from 10% to 85% for *S. typhimurium* LPS), but intravascular injection of 1 μ g of either LPS had no significant effect on frequency of resorption. Injection of 1 μ g or 5 μ g of either LPS reduced female body weight in a dose-dependent fashion. *S. typhimurium* significantly increased maternal spleen weight and increased maternal dorsal lymph node weight, but *E. coli* LPS had no significant effect on those organs. Neither detoxified LPS (lipid A removed) or purified lipid A from the LPS of either bacterial strain caused any significant increase in frequency of resorption or decrease in maternal body weight. These results indicate that intact LPS from *E. coli* was slightly more effective than intact LPS from *S. typhimurium* in causing resorption, but LPS from *S. typhimurium* caused stronger immune stimulation (as indicated by spleen and dorsal lymph node enlargement). The lack of effectiveness of either detoxified LPS or purified lipid A in causing resorptions indicates that the complete LPS molecule is required to induce resorption.

EMERGENCE STUDY OF THE PERIODICAL CICADA IN BOTETOURT COUNTY, VA, 1995 Philip C. Lee, Jr., Department of Biology, 221 College Lane, Roanoke College, Salem, VA, 24153. Counts were made of emerging nymphs of Magicicada septendecim (L.) during May and June, 1995. This was part of the seventeen year brood predicted for Botetourt County. A twenty-five meter wide and one-hundred twenty meter long area of lawn on the Lee farm was used as the study site. Trees and shrubs on the site included: ginkgos (2), white pines (2), red cedars (2), sugar maples (2), silver maples (3), pin oaks (3), willow oak, sweet gums (2), pears (3), golden rain tree, apples (2), redbud, dogwoods (3), catalpa, green ash, Pfitzer junipers (12), Japanese yews (7), Korean boxwoods (4), American boxwoods (5), leather leaf viburnums (8), doublefile viburnums (2), spirea, weigela (3), beautybush, lilacs (4), hardy-orange, Japanese quinces (2), deutzia. Crawling nymphs were captured by hand, counted and placed in collection bags. Largest counts were on May 21: 1,378; May 22: 1,534; May 23: 1,626. Total nymphs counted for the study: 8,028.

PREGNANCY BLOCK IN WHITE-FOOTED MICE (*PEROMYSCUS LEUCOPUS NOVEBORACENSIS*): THE ROLE OF LACTATION. Kelcey M. Becker, Elizabeth L. Spruill and C. Richard Terman, Lab. of Endo. & Pop. Ecol., Col. of William and Mary, Williamsburg, VA 23185. Uterine implantation of fertilized eggs (blastocysts) is prevented in several species of small mammals if the recently inseminated female is exposed to a stranger male or his urine. Some species of deer mice (*Peromyscus*) are susceptible to pregnancy blocking. Reproduction in wild white-footed mice has been shown to be suppressed in May and June each year even when food is supplied in surplus. This study examined the pregnancy block phenomenon in white-footed mice and demonstrated that: (1) Nulliparous females are very sensitive to multiple factors blocking their pregnancies, (2) Current lactation or recent lactation (within two or three days of the birth of young) protects the female against pregnancy block, and (3) Parity per se does not protect against pregnancy block (7 days after birth when not lactating, protection is gone).

THE EFFECTS OF SEX RATIOS ON PROLONGED COPULATION IN COTTON STAINER INSECTS (*DYSDERCUS ANDREAE*). A. Scott Bellows and Harold J. Grau, Dept. of BCES, Christopher Newport University, Newport News, Va. 23606. *Dysdercus andreae*, one of the cotton stainer species, as in many other bugs of the family Pyrrhocoridae, exhibits prolonged copulation. Prolonged copulation may be a successful mating strategy in situations where a male-biased sex ratio would likely increase competition among males for females. To test this hypothesis in *D. andreae*, a study was conducted in which the sex ratios of adult cotton stainers were manipulated and various parameters related to mating behavior were monitored. Over a five-month period, a total of 54 trials that included 291 individual insects were used to generate over 13,000 observations. There was a significantly higher probability of partner switching per observation among males in female-biased test populations than among those in both male-biased and non-biased test populations. There was a significantly higher probability of partner switching per observation among females in male-biased test populations than among those in both female-biased and non-biased test populations. Mean copulation duration was significantly longer in male-biased test populations than in female-biased test populations. The lack of an increase in copulation duration in female-biased populations, even though there is a decrease in partner switching by females, suggests that prolonged copulation among *D. andreae* is a strategy employed by males as a result of male-male competition.

THE FUNCTIONAL SIGNIFICANCE OF A MEDIALY DIVIDED CRIBELLA IN THE SPIDER GENUS *MALLOS* (ARANEAE, DICTYNIDAE). Jason E. Bond & Brent D. Opell, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The cribellum is a synapomorphy of the Infraorder Araneomorphae, where it first appeared as an oval plate (Platnick, 1976). However, in some anaraneomorphs the cribellum is divided medially. A transformational analysis that includes four species of the dictynid genus *Mallos* with entire cribella and two species with medially divided cribella shows that cribellum width, surface area, and spigot number scale to carapace width. There is no evidence that these relationships differ between species with entire and divided cribella. Thus, in *Mallos*, a median cribellar division does not appear to be associated with changes in cribellum features that are known to increase the stickiness of cribellar threads. (Supported by grants to JEB from: Sigma Xi, Graduate Student Association, Va. Tech, the American Museum of Natural History, and the Dept. of Biology, Va. Tech)

CHANGES IN NEURON POPULATIONS IN SPINAL GANGLIA IN THORACIC, ABDOMINAL, AND CAUDAL REGIONS OF *XENOPUS LAEVIS* DURING METAMORPHOSIS. A. C. Brooks and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va., 23005. Sensory neuron populations in *Xenopus laevis* tadpoles were studied during metamorphosis. Numbers of neurons in spinal ganglia in forelimb region sections significantly increased (ANOVA with Tukey test) as the forelimbs grew and began to function from stage 52 through stage 61, then significantly decreased through stage 66. The area of the ganglia in sections from the forelimb region increased significantly from stage 52 to stage 58, then decreased significantly through stage 66. Numbers of neurons in spinal ganglia in trunk region sections increased during skin metamorphosis from stage 52 through stage 58, then decreased through stage 66. The area of the ganglia in sections from the trunk region increased from stage 52 to stage 58, then decreased through stage 65 with a slight increase in stage 66. None of the changes in the trunk region were statistically significant. Changes in numbers of neurons and in area of the ganglia were much smaller in the trunk than in the forelimb region. Neuron density (cell # / mm²) did not change significantly from stage 52 through stage 66 in either the forelimb or trunk regions. These patterns suggest that numbers of neurons increased in response to increases in the tissues supplied by the neurons, then declined, possibly due to loss of neurons which failed to make proper connections. In general, area of the ganglia increased one to three stages prior to the corresponding change on number of neurons suggesting that changes in non-neuronal cells and/or in neuron processes precede changes in numbers of neurons.

DISTRIBUTION OF SMALL MAMMAL SPECIES IN MANAGED PINE PLANTATIONS. James D. Dolan, Old Dominion University, Norfolk, VA 23529. Abundances were obtained using mark, recapture and removal techniques. Four 50 m² grids, with 25 traps each, were set per site. Granivores were most abundant in 1 and 24 yr. pines, while insectivores were most abundant in those of 8, 13, and 18 yr. old stands. Herbivores were least abundant in 1, 8, 18, and 24 yr. old stands. Of the granivores, *Peromyscus leucopus* was the most abundant species in 1 and 24 yr. stands, while *Ochrotomys nuttalli* was the sole inhabitant of 8, 13, and 18 yr. stands. *Reithrodontomys humulis* was found in 1 and 14 yr. stands, while *Mus musculus* was found only in 1 yr. stands. Herbivore, *Sigmodon hispidus* was found in 1 and 24 yr. pines, and was most abundant in 1 yr. old pines. *Microtus pinetorum* was the sole resident in 8, 13, and 18 yr. pines. Insectivore, *Sorex longirostris* was the most abundant species in 8, 13, 18 and 24 yr. stands, and equal in abundance to *Cryptotis parva* in 1 yr. stands. *C. parva* was also found in 24 yr. old stands, but was the least abundant species. *Blarina brevicauda* was found at all sites.

THE LETHAL AND SUBLETHAL EFFECTS OF ALDICARB ON THE GRASS SHRIMP, *P. PUGIO*. Andrea L. Dvorak-Grantz, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The grass shrimp *Palaemonetes pugio* has been shown to be sensitive to pesticide exposure, yet these animals survive in large numbers in the upper reaches of tidal marshes subject to agricultural runoff. The behavioral responses of *P. pugio* to chemical stress at sub-lethal doses is not fully understood. Previous studies have focused mainly on the lethal effects of pesticides to aquatic organisms (Baughman, 1989; Clark, 1988). The specific intent of this research is to assess the lethal and sub-lethal effects of aldicarb, a commonly used insecticide, on *P. pugio*. Exposure of grass shrimp to aldicarb indicated a 96-h LC50 of 107.5 ug/l for newly hatched larvae, 72.4 ug/l for 22-day larvae and 100.0 ug/l for adults. Ongoing studies will determine any behavioral responses to different toxicant levels of aldicarb by using a modified flow chamber which will be partitioned to allow the organism a distinct choice between the side being pulsed with aldicarb and the side being pulsed with uncontaminated seawater. If the shrimp display behavioral responses to aldicarb, then avoidance, generalized locomotory responses and directional movement will be measured. AChE activity and inhibition at different life stages will also be analyzed since the inhibition of this enzyme may indicate the potential for sublethal neurological impacts. An understanding of the lethal and sub-lethal effects of aldicarb on *P. pugio* will assist environmental managers and regulatory agencies in evaluating the lethal and sub-lethal effects of nonpoint source pesticide runoff to nontarget invertebrates. Protection of this organism is vital in maintaining the integrity of estuarine systems since this organism serves as an important prey item for various fish species and plays a dominant role in energy cycles of estuaries.

ARTHROPODS IN BLUE BIRD (SIALIA SIALIS) NEST BOXES. Ralph P. Eckerlin, Natural Sciences Div., Northern Va. Comnty. Col., Annandale, VA 22003. Twentyeight nests from blue bird nest boxes were sampled May to August, 1995 at Huntley Meadow Park in Fairfax County, VA. Twelve of the nests were those of blue birds, 11 were house wren nests, 3 from Carolina chickadees, and one each of tufted titmouse and tree swallow. Nests were placed in a Berlese funnel, subjected to heat from a 75 watt bulb for 24 hours and arthropods that emerged from the nests were collected and preserved in 70% ethanol. Mites, psocids, and beetle larvae, in descending order of occurrence, dominated the nests of both blue birds and house wrens. Some mites were parasitic mesostigmatid mites, but most arthropods were free living forms such as oribatid mites, psocids, dermestid beetles, leaf hoppers, ants, collembolans, flesh flies and their larvae. Chickadee nests also had mites, psocids, and beetles. The nest of the tufted titmouse yielded a single flea, Orchopeas howardi, a squirrel flea. It is hypothesized that the nest was visited by a southern flying squirrel, a local squirrel that could fit through the nest box hole. Mite numbers increased in nests of all species from May to August. The increase was not significant at the 5% level (Wilcoxon rank-sum test). The saw-toothed grain beetle, Oryzaephilus surinamensis was an unexpected find.

THE EFFECTS OF FOOD TYPE ON DEVELOPMENT OF ST. ANDREW'S COTTON STAINER (DYSDERCUS ANDRAEAE). Harold J. Grau & Kevin McSweeney, Dept. of Biol., Chem., & Env. Sci., Christopher Newport Univ., Newport News, VA 23606. St. Andrew's cotton stainer is one species of a pantropical group of Pyrrhocorid bugs that feed predominantly on seeds of the plant order Malvales. On St. Thomas, USVI, *Dysdercus andraeae* feed almost exclusively on seeds of *Thespesia populnea*, a non-agricultural tree found along shoreline areas. To determine if a lab population of *D. andraeae* could be sustained on an alternative food, an experimental study was initiated in which broods were divided after the first molt into two groups and fed exclusively either *Thespesia* seeds or those of commercially available cotton (*Gossypium*). Videography was used to record development from the second instar through adult stages. Measurements of body size from these video records show that bugs reared on cotton seed grew significantly ($P < 0.01$) larger (both total body length and width) and faster than their *Thespesia*-fed broodmates. Cotton fed individuals also reached adult emergence five days more quickly than those fed on the native seed (mean age at emergence: cotton-fed = 39.45 days, *Thespesia*-fed = 44.05 days, $P < 0.001$).

AGGREGATION, MATING, AND OVIPOSITION BEHAVIOR OF ADULT Cuterebra fontinella Clark (DIPTERA: CUTEREBRIDAE). Michael S. Hensley, Dept of Biol., Bridgewater College, Bridgewater, VA 22812. An aggregation site for the rodent bot fly *Cuterebra fontinella* has been studied intensively during sixteen seasons. The site is a topographic summit at the head of a ravine on a farm woodlot in Rockingham County, VA. Adult flies engage in mating behavior at the site during a 90-100 day period from mid-June to mid-September. Behavior is generally typical for the genus with males stimulated into patrolling flights during intense light. Untypically, populations are sparse (< 8 males) and flight behavior is restricted to afternoons between 1520 and 1750 EST, even when mornings are warm and sunny. Marked, released flies located the aggregation site by moving up the ravine (into the sun). Ovipositing females range over the entire 6 ha woodlot and they seem to seek out shaded depressions in host habitat where eggs are laid in clusters of six.

GEOGRAPHIC VARIATION IN NORTH CAROLINA AND VIRGINIA POPULATIONS OF THE SOUTHEASTERN SHREW, Sorex longirostris, INCLUDING THE FEDERALLY THREATENED S. l. fisheri. Nancy D. Moncrief¹, W. David Webster^{2*}, Becky E. Gurshaw^{2*} and Robert K. Rose³. ¹Virginia Mus. Nat. Hist., Martinsville, VA 24112; ²Biol. Dept., Univ. North Carolina, Wilmington, NC 28403; & ³Biol. Dept., Old Dominion Univ., Norfolk, VA 23529. We used multivariate morphometrics and allozymic electrophoresis to examine the geographic distribution of S. l. fisheri. This taxon is federally listed, in part because it was thought to occur only in extreme southeastern Virginia and northeastern North Carolina. We used eight cranial characters to examine variation in 626 shrews from 28 populations in Virginia, North Carolina, and throughout the southeastern U.S. We also analyzed 25 presumptive gene loci in 103 individuals from 25 sites in Virginia and North Carolina. Both the morphological and allozymic results indicate that S. l. fisheri is broadly distributed across the coastal plain of North Carolina. The range of S. l. fisheri is not as restricted as was presumed.

RESPONSE BY SUBTERRANEAN TERMITES (RHINOTERMITIDAE: RETICULITERMES) TO UREA LEACHATES IN FIELD AND LABORATORY TRIALS. Susan E. Morlino & Deborah A. Waller, Dept. of Biol., Old Dominion Univ., Norfolk, Va. 23529. Little is known about how termites locate food sources. One possibility is that they follow chemical cues from nitrogen leachates to find roots or logs. In laboratory trials, Reticulitermes workers recruited to 1% (w/v) urea leachates sooner than to water drenches. In field trials, termites tended to attack blocks located above urea drenches more frequently than blocks above water drenches, but more data are required to establish a preference. In a separate field experiment, termites did not discriminate among stakes soaked in urea solutions or in water.

DISTRIBUTION OF HINDGUT PROTOZOANS IN WORKERS AND SOLDIERS OF THE SUBTERRANEAN TERMITE RETICULITERMES FLAVIPES KOLLAR (RHINOTERMITIDAE). Marian Norris & Deborah A. Waller, Dept. of Biol., Old Dominion Univ., Norfolk, Va. 23529. The hindguts of Reticulitermes flavipes contain approximately fourteen species of protozoan symbionts. Distribution of different species may be affected by their oxygen sensitivity or dependence on cellulose which enters the hindgut through the enteric valve. In the present study, three major protozoan species were found in all three pouches of the hindgut. Trichonympha was more abundant in the first pouch near the enteric valve, while Pyrsonympha and Dinenympha were more abundant in the second pouch.

EFFECTS OF TEMPERATURE ON SURVIVORSHIP AND SYMBIOTIC PROTOZOANS IN THE SUBTERRANEAN TERMITE *RECTICULITERMES VIRGINICUS* BANKS (ISOPTERA: RHINOTERMITIDAE). Jennifer Omaster & Deborah A. Waller, Dept. of Biol., Old Dominion Univ., Norfolk, Va. 23529. Termites are exposed to a range of temperatures as they forage throughout the year. In the present study, workers from six colonies of *Reticulitermes virginicus* were confined for one week at 22°C, 26°C or 32°C. Termite survivorship decreased at 32°C, but wood consumption increased with increasing temperature. Numbers of the gut protozoans *Trichonympha* and *Pyrsonympha* were similar at all three temperatures, but populations of the gut protozoan *Dinenympha* decreased at 32°C.

COMPARISON OF TISSUE DESTRUCTION, GRANULOCYTE DISTRIBUTION, AND C3 COMPLEMENT DISTRIBUTION AROUND NORMAL AND LIPOPOLYSACCHARIDE- INDUCED RESORBING EMBRYOS IN CD-1 MICE. J. E. Pulley and A. F. Conway, Dept. of Biol., Randolph-Macon Col., Ashland, Va., 23005, and C. M. Conway, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284-2012. Sections of implantation sites from control and LPS-treated pregnant mice were systematically surveyed and morphological characteristics were evaluated to determine whether LPS treatment increased inflammatory factors including tissue destruction (as evidenced by total peroxidase staining), granulocyte accumulation (as visualized by peroxidase staining resistant to inactivation by methanol+ peroxide), and complement deposition (as visualized by staining with antibodies against C3). Activity of each of these factors was ranked in a set of sections from implantation sites from females sacrificed at increasing time periods after LPS or control treatment (6, 12, 18-19, 24-29 hours). Total peroxidase staining and apparent tissue destruction were significantly increased in the decidua in the placental margin region and in the maternal-embryonic interface of the central placental region of implantation sites in LPS-treated females at 6 hours after treatment. Granulocytes (stained for methanol+ peroxide-resistant peroxidase) and immunostaining for complement factor C3 were not significantly increased in those or in other areas of the maternal-embryonic interface in implantation sites from LPS-treated females indicating that damage in early stages of LPS-induced resorption does not involve these components.

MATE SELECTION AND THE EVOLUTION OF SEXUAL DICHROMATISM IN THE GENUS *EULEMUR*. Douglas H. Shedd, Dept. of Biol., Randolph-Macon Woman's Col., Lynchburg, VA, 24503. All of the species and subspecies in the genus *Eulemur* are sexually dichromatic. In this study, conducted at the Duke University Primate Center, captive *E. mongoz*, *E. m. macaco*, and *E. fulvus collaris* were tested using conspecific face models to investigate the significance of sexual dichromatism. It was found that females in all three species directed more affiliative behavior to male-faced models than female-faced models, and this difference was significant in *E. f. collaris* and *E. macaco*. In contrast, males did not consistently favor models of either sex and, in general, tended to show less affiliative behavior to face models than did females. Preliminary research on *E. mongoz*, *E. m. flavifrons*, and *E. fulvus* subsp. suggest that female dominance, which is typical of most lemur species, is absent in *E. fulvus*. A general model for the evolution of sexual dichromatism, based on the high level of female choice occurring in primate species displaying natal female emigration, and forest fragmentation, is proposed.

THE ROLE OF FEMALE POSITIONAL CHOICE IN PREGNANCY BLOCK (THE BRUCE EFFECT) IN PRAIRIE DEERMICE (*PEROMYSCUS MANICULATUS BAIRDII*). Tavis W. Sipe and C. Richard Terman, Lab. of Endocrinology and Population Ecology, Dept. of Biology, Col. of William and Mary, Williamsburg, VA 23185. Female *Peromyscus* are able to behaviorally modulate pregnancy block effect through positional choice when males are unable to directly influence situation. Female tends to avoid strange male under all conditions, but there is no tendency to remain near stud male when strange male is not present. Familiar males, those present at the time of insemination but not the coital partner, are treated similarly to stud rather than strange males, indicating that cues for detecting whether a male is capable of causing block do not include insemination. Pregnancy data indicate partial ability to avoid block through avoidance of strange male under experimental conditions; in wild populations this may serve to protect the female unless the stud male is no longer present. These results are reconcilable with the predominant explanation of the adaptive significance of pregnancy block to females, the "infanticide avoidance" theory; the fact that the female is not wholly able to avoid the block (physiologically or behaviorally) indicates that the block is to some degree advantageous to her when she is unable to prevent it.

THE EFFECTS OF ATRAZINE ON NITROGEN CYCLING IN WETLANDS. Rhonda E. Wilhite, & A. L. Buikema, Dept. of Biol., Va. Tech, Blacksburg, Va. 23284. Wetlands are ecologically important zones which remove excess nitrogen and agricultural chemicals from surface and groundwater. Atrazine, the most commonly used herbicide, is rapidly accumulating in surface and groundwater. Atrazine's impact on the Nitrogen cycle in a freshwater wetland is currently unknown. It is hypothesized that the addition of Atrazine to a wetland microcosm will alter the Nitrogen cycle by inhibiting nitrifying bacterial groups. This inhibition of the inorganic cycling of Nitrogen may result in an excess of Nitrogen compounds entering waterways. Seven subsamples were collected from a wetland and established in a controlled environment in the laboratory with a continual supply of water. Three of these microcosms were treated with Atrazine at a concentration of 1.5 mg/l. Bacterial groups were enumerated by a Most Probable Number method using selective media. Inorganic Nitrogen components were quantified by spectrophotometric analyses. Results show that these Nitrifying groups were not significantly affected by the addition of Atrazine to the microcosms. Significant increases were noted in the concentrations of Nitrite ($P=0.0061$) and Nitrate ($P=0.0001$) present in water leaving the microcosm. This is not surprising given the fact that these anions are readily leached from the soil. Ammonium and Nitrite oxidizing bacteria were previously thought to be sensitive to Atrazine at high concentrations. Because of their affiliation with the surrounding sediments, these bacteria are not as susceptible to stress in the environment. In conclusion, the addition of Atrazine to a freshwater wetland microcosm does alter the Nitrogen cycle, producing excess Nitrite and Nitrate. Also, Nitrifying bacteria are not affected by Atrazine at this concentration.

HABITS AND MATING BEHAVIOR OF CAPTIVE ALLEGHENY WOODRATS (*Neotoma magister*). Andrew K. Zadnik & Michael T. Mengak, Dept. of Life Sciences, Ferrum College, Ferrum, VA 24088. Two woodrats were studied in captivity in order to observe their typical nocturnal habits and mating behavior. It was found that they spend most of their time resting and sleeping (68.3% of time). The next longest period of time was spent exploring (10.3% of time) and grooming (10.3% of time), followed by eating (9.6% of time) and finally defecating (1.5% of time). Their mating habits include sexual chases, boxing, and multiple matings over a short period of time. They also may be capable of mating many times without the female necessarily becoming pregnant.

Biomedical and General Engineering

BLOOD FLOW PATTERN STUDY OF HUMAN CAROTID ARTERIES USING ANGLE INDEPENDENT DOPPLER COLOR IMAGING. Danhui D. Liu¹, Ding-Yu Fei^{1*}, Cai-Ting Fu^{1*}, Raymond G. Makhoul^{2*}, and M. Ruth Fisher^{2*}, ¹Dept. of Biomedical Engineering and ²Dept. of Surgery, Va. Commonwealth Univ., Richmond, Va 23298. The flow information obtained from commercially available ultrasonic Doppler color imaging system depends on the Doppler angle. Angle correction by duplex scanning may introduce errors for complex geometry and pathological conditions such as stenosis. Angle Independent Doppler Color Imaging (AIDCI) developed in our lab is one of the image processing methods used to solve this problem. It employed an experimental system to acquire Doppler color images using a linear transducer from an ultrasound scanner to reconstruct angle independent Doppler color images. We have tested 42 common carotid arteries (CCA) from 21 normal subjects to validate the application of AIDCI *in vivo*. Furthermore, we conducted a retrospective study on 62 internal carotid arteries (ICA) from normal subjects and patients categorized into 5 groups of different degree of stenosis. The purpose of the ICA study was to quantify the blood flow patterns by some user-defined indices in an attempt to parameterize the degree of disease. Good correlations were found between AIDCI and duplex scanning for velocity amplitude and between AIDCI and B-mode imaging for flow angle. We also observed a periodic variation of the flow angle with the cardiac phases by AIDCI, while the change in the geometric angle of the vessel was insignificant. In addition, preliminary statistical analysis showed significant difference of the indices between different groups. These results suggested that our AIDCI technique may be sensitive to the change of flow angle and therefore may be used in blood flow pattern analysis. Potential application of our AIDCI technique can be expected in hemodynamic study and diagnosis of degree of disease using the flow patterns and the indices as indicators of abnormality.

ISOLINES OR TESSELLATION LINES, WHICH WILL IT BE ? William P. Harrison, Engineering Fundamentals Div., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0218. In current computer-aided-design (CAD) usage, tessellation lines are defined as those lines that help us more easily visualize the features and characteristics of curved surfaces. They may be straight lines, such as the linear element lines added to cylindrical surfaces and running in the lengthwise direction; or they may be curved lines, such as circular arcs added to spherical surfaces to clarify and visually enhance their three-dimensional spatiality. However, the word tessellate dates back to early Greek and Latin origins, where it had a connotation somewhat different from its present usage within the CAD software community. This paper attempts to trace the recent transition of the word tessellation from its classical usage, as it appears currently in most traditional dictionaries, to its widely accepted "new" usage within the engineering and graphic arts fields. Also, tessellation is compared to the very recently introduced term ISOLINE, and speculation about its possible replacement is presented.

DETERMINATION OF RED BLOOD CELL VELOCITY AND SPATIAL DISTRIBUTIONS USING A VIDEO IMAGING TECHNIQUE. Shruti A. Japee and Roland N. Pittman. Departments of Biomedical Engineering and Physiology, MCV/VCU, Richmond, VA 23298.

Since oxygen is carried almost exclusively by red blood cells (RBC), a knowledge of their velocity and spatial distributions in the microcirculation is important in the study of oxygen transport. RBC velocity and spatial distributions in microvessels were determined using a fluorescent video microscopy technique that used electronic shuttering of an intensified CCD video camera to provide multiple images of cells. RBCs from anesthetized Golden hamsters were labeled using fluorescein isothiocyanate (FITC) and injected into the hamster circulation. The fraction of fluorescently labeled cells (FRBC) was set to about 1% of the total RBCs, so that each video frame had 1-2 FRBCs. Video recordings of multiple images of moving FRBCs were used to calculate their velocities and lateral positions. A theoretical model, based on a parabolic velocity profile, $v(r) = v_0 [1 - B (r/R)^2]$, and a step-wise red cell distribution, $H(r) = H_0$ for $0 \leq r \leq r_0$ and zero elsewhere, was formulated to analyze the data. The shape of the RBC velocity profiles varied as a function of distance downstream from arteriolar bifurcations. The bluntness parameter, B, ranged from 0.3 to 0.9, where B = 0 corresponds to plug flow and B = 1 to Poiseuille flow. Symmetry of an RBC spatial distribution was assessed by comparing the number of FRBCs to the left and right of the centerline. Symmetry of velocity distributions was evaluated similarly. We observed both symmetric and asymmetric distributions of RBCs near bifurcations, but contrary to our expectations, the symmetry did not seem to improve with downstream distance. The asymmetry, if any, in the velocity distributions was comparatively small. Results from these experiments will be used in combination with measurement of hemoglobin and oxygen saturation to obtain improved estimates of convective and diffusive oxygen transport in microvessels.

A u-p FINITE ELEMENT ANALYSIS TO INVESTIGATE LOAD SHARING BETWEEN SOLID AND FLUID PHASES ON AN ARTICULAR SURFACE. Nilay Mukherjee and Jennifer S. Wayne*, Orthopaedic Research Laboratory, Va. Commonwealth Univ., Richmond, Va. 23298-0694. Articular cartilage successfully functions in the demanding environment of diarthrodial joints because of its structural makeup and lubrication mechanisms between opposing surfaces. The biphasic theory¹ postulates that the stress within the tissue is shared by both solid and fluid phases of the tissue. It has been suggested that an externally applied stress is also partitioned to the two phases at the surface². Different amounts of partitioning has a dramatic effect on cartilage behavior³. This study attempts to determine the load partitioning at the surface between the two phases of cartilage under in situ loading, combining both experimental and theoretical modelling approaches. Porcine knees were subjected to a 450N compressive load while fluid pressure at the cartilage surface and cartilage deformations during the loading were monitored⁴. For the modelling, the u-p finite element model⁵ was used to simulate the cartilage in the experimentally loaded knee. Experimental pressure readings provided loading information to the model and the model then predicted the deformations of the cartilage due to the loading. Deformations for the model were obtained for four cases 1)30% of the total stress was partitioned to the fluid 2)50% 3)70% 4)90%. Load partitioning was assumed to be constant across the cartilage surface and over the duration of the experiment. Experimental and predicted deformations were compared at two time points during the loading to determine which partitioning case provided deformations closest to the experimentally obtained deformations. Best correlations are obtained for the case where 70% of the load is borne by the liquid. This agrees well with earlier theoretical predictions of load partitioning². 1)Mow et al., J. Biomech Eng, 102:73-84, 1980 2)Hou et al., J Biomech Eng, 111:78-87, 1989, 3)Wayne, Ann Biomed Eng, 23:40-47, 1995, 4)Brodrick et al., Trans ORS, 21(2):737, 1996, 5)Wayne et al., J Biomech Eng, 113:397-403, 1991. Support from Whitaker Foundation is gratefully acknowledged.

ESTIMATION OF CONDUCTION VELOCITY OF Aδ FIBERS USING HEAT-PAIN RELATED SOMATOSENSORY EVOKED POTENTIALS IN HUMANS. Arup Roy¹ & S.W. Harkins^{1,2*}, Depts. of ¹Biomed. Engr., ²Gerontology, & ³Psychiatry, Va. Commonwealth Univ., Richmond, Va. 23298. Estimation of large peripheral nerve conduction velocity (CV) is a common component of determination of peripheral nerve damage in clinical studies. These cutaneous fibers have a high S/N ratio and are easily studied in response to appropriate cutaneous stimuli. Currently there are no available means for determination of CV of small cutaneous fibers which subserve pain perception. The present study was designed to evaluate the potential utility of a contact thermal stimulator in determination of CV of cutaneous fibers subserving thermal pain (nociception) sensitivity in humans. The stimulator delivers a brief duration, fast rise-time (21.7°C/s) heat pulse to the skin without contamination by other stimulus modalities. Averaged somatosensory evoked potentials (SEPs) to thermal stimuli were employed as possible markers of conduction properties of nociceptive neurons. The individual responses were digitally band-pass filtered (0.5-7.0 Hz) to remove high frequency noise and exclude gross artefacts. The single trial SEPs which had very low correlation (similarity) to the average SEP were eliminated by a selective averaging technique which used a test statistic based on the Fisher transformation. To obtain a final estimate of the waveshape representative of the highest mutual correlation among all the responses, the selected single trial SEPs were passed through an adaptive cross-correlation filter (Woody filter) for latency corrected averaging. The CV of the Aδ fibers were then estimated from the difference of the peak latencies of the arm and leg cortical potentials. We have determined that EPs to the thermal stimuli are maximal in amplitude at vertex (C_z). Our studies show that the CV from these SEPs is consistent with their arising from Aδ fibers. These are probably the first findings suggesting that a simple, contact thermal stimulus may permit identification of small fiber conduction delays in individuals with and without painful peripheral neuropathies.

ACCELERATED CONSTRUCTION OF THREE-DIMENSIONAL ISOSURFACES FROM MEDICAL IMAGES. John E. Stewart and William C. Broaddus*, Dept. of Biomedical Engineering and Div. of Neurological Surgery, Va. Commonwealth Univ., Richmond, Va. 23298. Computer graphics applications to medical visualization have grown significantly over the last twenty years. Many medical institutions now have the ability to visualize three-dimensional (3D) models of the human anatomy on high-speed graphics workstations. These models typically require hours to generate and minutes to render to the computer screen. This severely limits the utility of these models for everyday patient care. In order to resolve these problems, we have developed a number of unique algorithms to accelerate both the creation and rendering of these models. One such algorithm, Border Case Comparison, creates coherently-oriented manifold isosurfaces from MR or CT scans at a rate of 30 K triangles/second. A typical 3D model can be created from 40 CT scans in under five seconds. The rendering of these models has also been accelerated through the use of an optimized surface simplification algorithm. The purpose of this algorithm is to reduce the overall number of triangles necessary to render the model without significantly altering the appearance of the model. A model consisting of 100 K triangles can be simplified to contain 20 K triangles in less than 10 seconds with virtually no deterioration in model quality. This simplified model will render on a Silicon Graphics Indigo2 workstation in under 0.5 seconds. A software system entitled IsoView has been developed to incorporate all of these algorithms into one package. The strides made in accelerating the process of going from medical images to 3D computer model have provided a practical means of visualizing and planning neurosurgical procedures on a daily basis.

ENGINEERING AND TECHNOLOGY IN A SUMMER SCIENCE CAMP. JoAnne P. Trimbur and Lynn Lambert, Dept. of Physics and Computer Science, Christopher Newport Univ., Newport News, VA 23606. Research has shown that a significant deterrent to women in engineering is their relative lack of prior experience with hands-on activities which develop building or design skills, particularly those activities involving the use of tools. A 3-week semi-residential summer science camp for 24 middle school girls from rural areas emphasized several areas of engineering/technology, including LEGO robot design, computers and the Internet, engineering design contests, and two building projects which involved the use of a variety of tools. The use of tools was, for the majority of the girls, the most foreign concept of any included in the curriculum. The students spent a total of 4 hours building their own table lamps and building and racing their own 1/20 scale solar cars. Tools used in these projects included wire strippers, wire cutters, needle-nose pliers, and Phillips' head and regular screwdrivers. All 24 girls produced working lamps and working solar cars. By the end of these sessions, the girls had become significantly more comfortable with the use of simple hand tools and had gained confidence in their ability to successfully complete projects requiring use of tools. At a follow-up meeting with the girls and their parents four months later, the parents related several anecdotes about their daughters' newly acquired habits of taking household items apart and putting them back together. Many of the table lamps built by the girls were still in use in their homes eight months after the summer camp. Several of the students have expressed an interest in careers in engineering. (This work supported by NSF grant number HRD-9453678)

HINT AND SYBYL: MODELING AND QSAR STUDIES OF HIV-1 PROTEASE INHIBITORS. David T. Wei*, Dept. of Biomedical Engineering, Va. Commonwealth Univ., Richmond, VA 23298, & Glen E. Kellogg, Depts. of Medicinal Chemistry and Biomedical Engineering, Va. Commonwealth Univ., Richmond, VA 23298. Rational drug design has garnered considerable interest in recent years. A key advantage of the method is the ability to evaluate potential therapeutic agents before synthesis. Current research in AIDS therapy has centered on HIV-1 protease inhibitors. Using a training set of 33 inhibitors (Holloway, M.; *et al.* "A Priori Prediction of Activity for HIV-1 Protease Inhibitors Employing Energy Minimization in the Active Site." *J. Med. Chem.* 1995, 38, 305-317.), it has been demonstrated that a high correlation exists between the intermolecular interaction energy and the observed *in vitro* enzyme inhibition. Many computational tools have become available, but few take into account hydrophobicity and hydrophobic interactions. An empirical model has been developed, called HINT (Hydropathic INTERactions). Using HINT and the set of 33 inhibitors, we have been able to improve upon published results. Limitations of the Holloway *et al* model, including the flexibility of the enzyme active site; the energy difference between the bound and free inhibitor; and hydrophobic interactions, were also taken into account with this new approach. In essence, our model would seem to be more accurate and representative than previous models.

Botany

BIOMONITORING A NEW TECHNOLOGY COAL FIRED POWER PLANT- PRE-IMPACT STUDIES. Stephen W. Fuller and Susan T. Lee, Dept. of Biol., Ray B. Scott and Jim Turns, Dept. of Chem., Mary Washington Col., Fredericksburg, Va. 22401. A new coal-fired power generation plant with selective catalytic reduction of pollutants is being built next to an EPA designated non-attainment air pollution zone. Lichens on oak trees are being used as biomonitors of air pollution to determine if the plant emissions will have no measurable impact. Prior to start up, 22 free standing trees greater than 40cm diameter were selected, 11 surrounding the plant site and 11 upwind, serving as a control. A time series analysis was initiated in January 1996 with collections for metal analysis and photographs for growth determination. Initial analyses of metal concentrations in lichens collected in the impact area indicate that the concentrations are between those Lawrey (1993) reported from sites 15 and 21 km. from the center of Washington D.C. Comparison of the lichen thalli photographs from the winter and spring seasons show average growth rates of 0.51 and 0.91 mm/year in the control and impact sites, respectively. These rates are not statistically different and are similar to those reported by Showman (1976).

LICHENS AS BIOMONITORS OF AIR POLLUTION. Fuller, Stephen W. and Nicole Lemieux*, Mary Washington College, Fredericksburg, Va. 22401. A coal-fired power generation plant with selective catalytic reduction of pollutants is under construction in King George County, which is next to Stafford County, Va., an EPA designated non-attainment air pollution zone. Lichens on oak trees are being used as biomonitors of air pollution to determine if the powder plant emissions will have a measurable impact. Prior to power plant start up, 18 free standing oak trees greater than 40cm diameter, within an 20 km radius of the site were sampled; 15 lichen species were found. An Index of Atmospheric Purity (IAP) was derived which indicated that lichen stands in rural sites were more depauperate than those along a well used highway. As opposed to the findings of Pirintsos, et.al.(1993), higher IAP values were obtained at breast height than at the base in 8 of the 13 sites were basal studies were possible. However, statistical analysis indicates that there is no significant difference between the IAP's at the two heights.

THE GENUS *TETRACOCCLUS* IN NORTH AMERICA. W. John Hayden, Dept. of Biology, Univ. of Richmond, Richmond, Va. 23173. *Tetracoccus* is a genus of xerophytic shrubs native the southwest US and Mexico. Features of leaf morphology, staminate inflorescence, the gynoeceum, and seed structure prove useful in distinguishing five species which are: *T. ilicifolius*, endemic to the mountains around Death Valley; *T. dioicus*, an element of the coastal chaparral of southern California and northern Baja; *T. capensis* from the extreme southern Baja; *T. hallii* from the Sonoran Desert; and *T. fasciculatus* from the Chihuahuan Desert. Several small range extensions are noted since the last monograph of the genus, but all species remain fully allopatric. Contrary to indications in previous literature, some species of *Tetracoccus* prove to have biseriate perianth, i.e., both sepals and petals, a feature indicative of a relatively primitive position for the genus within subfamily Oldfieldioideae.

PHYLOGENETIC CONSTRUCTION WITH THE MATK GENE: WALKING ALONG THE GENE. Khidir W. Hilu and Hongping Liang, Dept. of Biol., Va. Polytechnic Inst. and State Univ., Blacksburg, Va. 24061. The surge in the application of molecular biology information to systematic and evolutionary questions has resulted in significant contributions to systematic biology. This paper addresses the utility of sequence variation in the *matK* gene for constructing phylogenies at and above the family level, and examines the rates, patterns and types of nucleotide substitutions in the gene. The results of this analysis were also used to address basic questions in plant molecular systematics and evolution such as sample size, number of characters (informative mutations), and weighting transversion mutations. The results underscored the high rate of substitution in the gene and the presence of mutationally conserved sectors. The use of different sectors of the gene and the cumulative inclusion of informative sites showed that the 3' region was most useful in resolving the phylogeny, and that the topology and robustness of the tree reached a plateau after the inclusion of 50 informative sites from that region. The potential use of partial sequencing provides the opportunity for increasing the sample size of the group at the expense of the number of nucleotides used. The presence of a relatively conserved 3' region and the less conserved 5' region provides two sets of characters that can be used at different taxonomic levels from the tribal to the division levels.

APPLICATION OF THE MATK GENE SEQUENCE TO PHYLOGENY OF THE GRASS FAMILY (POACEAE). Hongping Liang and Khidir W. Hilu. Dept of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. 920 base pairs of the 3' region of the *matK* gene was sequenced from 39 grass species (Poaceae) representing 26 tribes and 6 subfamilies in order to investigate the circumscription and phylogeny of grass subfamilies and tribes. With *Joinvillea* (Joinvilleaceae) and *Flagelaria* (Flagelariaceae) as outgroups, the aligned sequences were analyzed by the Wagner parsimony and Neighbor-Joining Methods using PAUP and MEGA. Out of the 920 base pair used, 32% were variable and 15.2% were informative. Both parsimonious and strict consensus tree show well resolved major clades that represent the grass subfamilies. *Pharus* was basal to all grasses, and the Bamboisidae and Oryzoideae branched off after *Pharus*. Arundinoideae was the basal to the well resolved PACC group (Panicoideae, Arundinoideae, Centothecoideae, and Chloridoideae). The monophyly of the Chloridoideae was supported by both parsimonious and Neighbor-Joining trees. More variable 5' region of the *matK* gene might be needed to address the branching pattern at the tribal level.

TOXIC PRODUCING ALGAE IN CHESAPEAKE BAY. H. G. Marshall. Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266. In Chesapeake Bay, 12 potential toxin-producing species are identified, representing approximately 1.7% of the phytoplankton in the Bay. If historical records of 3 other toxin-producing species are included, this would represent 2.1% of the total (Marshall, 1994). Species recognized as toxin producers are diatoms *Amphora coffeaeformis*, *Pseudo-nitzschia seriata*, and *P. pseudodelicatissima*; dinoflagellates *Cochlodinium heterolobatum*, *Dinophysis acuminata*, *D. acuta*, *D. caudata*, *D. fortii*, *D. norvegica*, *Gyrodinium aureolum*, *Pfiesteria piscicida*, and *Prorocentrum minimum*. No major toxic blooms and fish kills have been produced in the Bay to date. The above species may represent non-toxin producing strains, or may lack the required environmental conditions for major bloom and toxin production. Early historical records of toxin producers also include *Alexandrium catenella*, *Gonyaulax polyedra*, and *P. multiseriata*. Supported in part by the Virginia Dept. of Environmental Quality and the EPA.

THE DISTRIBUTION AND ECOLOGY OF HARPER'S FIMBRISTYLIS (*Fimbristylis perpusilla*) IN VIRGINIA. Thomas J. Rawinski, Va. Dept. of Conservation and Recreation, Div. of Natural Heritage, Main Street Station, 1500 E. Main St., Suite 312, Richmond, Va. 23219. Harper's fimbriatylis (*Fimbristylis perpusilla*) is a globally rare annual sedge. The 10 Virginia populations of the species occur in seasonal ponds near Grafton in York County. Population size in 1995 ranged from a single plant to more than 10,000 individuals. Germination began with the onset of draw-down conditions, which occurred on or about 28 June at most of the ponds. Spikelet-bearing culms were evident on 6 July at the first pond to draw down, and on 27 August at one of the last ponds to draw down. Soils were mucky and strongly acidic, with an average pH of 3.7. *F. perpusilla* occurred within a community classified as the *Lindernia dubia-Eragrostis hypnoides-Panicum dichotomiflorum* Association. *Panicum verrucosum*, *Fimbristylis autumnalis*, and *Juncus repens* were the most frequent associates of *F. perpusilla*. At several ponds, most of the *F. perpusilla* plants were out-competed by larger annuals. Water returned to the ponds during late January, 1996, and presently water levels are much higher than during similar dates in 1995. Monitoring of the *F. perpusilla* populations will continue through 1996.

AFRICAN VIOLET ARTIFICIAL SEEDS. Michael H. Renfro, Dept. of Biology, James Madison University, Harrisonburg, VA 22807. Artificial seeds provide a means for mechanized field planting of clonally propagated plants. In addition, artificial seeds facilitate distribution and storage of select germplasm. Somatic embryos or shoot tips can be encapsulated in an alginate matrix to form an artificial seed. Shoot primordia were excised from African violet (*Saintpaulia ionantha*) and were encapsulated in alginate. The alginate drops containing shoot primordia were complexed for various times to determine the effect on shoot growth and emergence. Artificial seeds were planted on several media including two tissue culture media, vermiculite, and a peat-based potting medium. Complexing time had no effect on emergence within the times tested, which ranged from 30 to 75 min. Best growth was obtained from seeds planted on tissue culture media. The size, condition and ontogenetic stage of the embedded shoot tip had an effect on the subsequent growth. Results indicate that encapsulated shoots of African violet can serve as artificial seeds for this plant species that does not commonly form natural seeds.

CHLOROPLAST DNA RESTRICTION SITE VARIATION AND PHYLOGENETIC RELATIONSHIPS OF HELENIUM SPECIES. Andrew Rice, John Knox* & Maryanne Simurda, Biol. Dept., Washington & Lee Univ., Lexington, VA. 24450. An initial survey of chloroplast DNA (cpDNA) polymorphisms for groups of 13 populations of the *Helium autumnale* species complex is being done for a phylogeographic study. Grouping of the populations is based on morphological lineages revealed in our previous common garden studies. These groups include, one broad-leaved lineage of plants from Vermont and Virginia, and three narrow-leaved lineages from Canada, New Jersey, Missouri, and Virginia. The narrow-leaved lineage from Virginia has been treated by some as a global endemic, *H. virginicum*. Our morphological studies found *H. virginicum* to be scarcely distinct from the Missouri population, thus suggesting a disjunction in this lineage or a vicariance pattern between Virginia and Missouri. Thus far, partial analysis of one single-copy region of the chloroplast DNA using 7 restriction enzymes have shown 24 restriction site changes in individuals of the *H. autumnale* populations and in individuals in the *H. virginicum* populations when compared with sites in the *Lactuca* chloroplast DNA. No significant differences among the populations have been detected.

A STAINING TECHNIQUE FOR THE ENUMERATION OF DINOFLAGELLATE CYSTS FROM NATURAL SEDIMENTS. David Seaborn. Dept. of Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266. Natural sediment samples containing dinoflagellate cysts were obtained through the use of a box corer. The sediment samples were marked with the polysaccharide stain, primuline. Samples were observed under epifluorescence microscopy using a near blue light filter. The primuline stained samples were faster to enumerate, and more individuals were observed due to the fluorescence. Bloom samples from the Chesapeake Bay were also stained. The dinoflagellates that were successfully stained and identified included *Ceratium tripos*, *Gymnodinium splendens*, *Heterocapsa triquetra*, *Prorocentrum minimum*, and *Scrippsiella trochoidea*. The use of this stain may be a successful tool in mapping past dinoflagellate blooms and potential bloom areas before the blooms occur.

THE VIRGINIA PITCHER PLANT BOGS. IV. SEED DISPERSAL AND DISSEMINATION IN A SUFFOLK COUNTY POPULATION OF *SARRACENIA FLAVA* L. Philip M. Sheridan. Dept. of Biol., Virginia Commonwealth University, Richmond, Virginia 23284. A historic site for *Sarracenia flava* was rediscovered during 1983 in Suffolk County in depauperate condition. The bog had been mined for clay in previous decades and efforts were made to clear local vegetation to revive the colony. When these efforts failed forty rhizomes were relocated within the clay pits to open habitat on clay islands or shores within the extensive water-filled pits. After three years, flowering was observed and by 1991 several seedlings were found. Seedlings and young plants increased to 30 and 149 individuals by 1993 and 1996 respectively. Recruits were observed a maximum of 300 feet from parents and colonization occurred on exposed clay soils on islands and occasionally on slightly higher grassy ecotones. *Sarracenia* seeds are highly hydrophobic and it is hypothesized that this dissemination occurred through flotation or to a much smaller extent by adherence to the feet of migratory animals.

SYSTEMATICS OF BRACKEN FERN IN EASTERN U. S.: ISOZYMES AND MORPHOLOGY. William D. Speer, Khidir W. Hilu, Dept. of Biology, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061, & Charles R. Werth*, Dept. of Biological Sciences, Texas Tech Univ., Lubbock, TX 79409. Bracken is the world's most common fern and one of the most common vascular plants. Although currently treated as a single species, *Pteridium aquilinum* (L.) Kuhn, many systematists feel that the two bracken subspecies and perhaps some of its twelve varieties should be raised to the species rank. This study addressed this question by examining the two most common varieties in the eastern United States, var. *latiusculum* and var. *pseudocandatum*, using isozymes and morphology. Fourteen isozyme loci were examined in ten bracken populations. The ten populations were very similar having a mean genetic identity of 0.973, which is in the range of values observed in angiosperms for conspecific populations. Possible gene flow between the two varieties was observed in one of the populations. Isozyme results were consistent with a single species treatment of the two taxa studied. Quantitative and qualitative characters were used both together and separately in the morphological study. Qualitative characters gave the best separation of the two taxa. Isozyme and morphological data indicate that these two taxa should be treated as two varieties of the same species.

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY OF CHLOROPHYLLS AND CAROTENOIDS FROM MESOCOSM TANKS OF VARYING SIZE AND SHAPE. Carey P. Willey, Horn Point Environ. Lab., Cambridge, Md. and Dept. of Biol., Randolph-Macon Col., Ashland, Va. 23005. The Multi-scale Environmental Ecosystem Research Center project (MEERC) is a ten-year long experiment in which mesocosms were created in five different sized and shaped tanks and the tanks are monitored and sampled over time. The chlorophyll and carotenoid composition of filtered water samples from the mesocosms were analyzed by HPLC. The tanks were initially filled with Choptank River water, and 10% of this water was removed and replenished everyday. Data was collected for two experiments; the first in spring 1994 and the second following a nutrient enrichment in summer 1994. The Choptank River, an estuary of the Chesapeake Bay, was sampled and correlated with the monitored activity in the tanks. The concentrations of signature pigments were used with chlorophyll a/pigment ratios characteristic of different algal classes to derive the composition of phytoplankton in the tanks. Diatoms and cyanobacteria made up most of the biomass of the tanks based on ratios to chlorophyll a concentration. A negative correlation between bloom and decline was observed among populations of diatoms and cyanobacteria in most tanks. Dinoflagellates declined drastically in all experimental tanks except for Choptank, where peridinin contributed largely to the chlorophyll a concentration. This is opposite from the experimental tanks, where diatoms contributed significantly to chlorophyll a concentration. Nitrate data was obtained to explain the inverse relationship of diatoms and cyanobacteria. The two pigments appeared to compete for the available nitrate. Replication between tanks of the same set was analyzed, and the larger diameter tanks had better replication.

Chemistry

METAL-TEMPLATED SYNTHESIS AND CHARACTERIZATION OF LANTHANUM(III) COMPLEXES OF PERIPHERALLY MONO-SUBSTITUTED SIX-NITROGEN DONOR MACROCYCLIC LIGANDS. A. M. Adeviga(*), Chemistry Department, Bennett College, Greensboro, NC 27401 and L.M. Vallarino, Chemistry Department, Virginia Commonwealth University Richmond, VA 23284. The synthesis of lanthanum(III) complexes of six-nitrogen-donor macrocyclic ligands with a single peripheral substituent was investigated using three related approaches: (1) Direct mixed template synthesis, consisting of the lanthanum(III)-templated cyclic Schiff-base condensation of 2,6-diacetylpyridine with a mixture of 1,2-diaminoethane and a carbon-substituted diamine, $H_2N-CH_2-CH(R)-NH_2$, in a 2:1:1 ratio; (2) Treatment of a pre-formed non-substituted La(III) macrocyclic complex with a carbon-substituted diamine in a 1:1 ratio, under conditions designed to promote transamination; and (3) Two-step synthesis, consisting of the acid-catalyzed Schiff-base condensation of 2,6-diacetylpyridine with 1,2-diaminoethane in a 2:1 ratio, to produce a (non-substituted) open-chain diimine-diketone, followed by a lanthanum-templated ring-closure reaction with a carbon-substituted 1,2-diaminoethane. The latter approach was successful and six mono-substituted species, $\{La(C_{22}H_{25}N_6(R))\}^+$, in which R is $-CH_3$, $-CH_2OH$, $-C_6H_5$, $-CH_2-C_6H_5$, $-CH_2-C_6H_4-OH$ and $-CH_2-C_6H_4-NH_2$, were obtained in 60-75% yields. (Supported by Coulter Electronics, Hialeah, FL, Newport Instruments, San Diego, CA, and Virginia Commonwealth University, Richmond, VA.)

CONSTITUTIONAL AND STERIC ISOMERISM IN COMPLEXES OF La(III) WITH DI-METHYL-SUBSTITUTED SIX-NITROGEN-DONOR MACROCYCLIC LIGANDS. F. Benetollo(*), I.C.T.I.M.A. - C.N.R., Padova, Italy, G. Bombieri(*), Istituto di Chimica Farmaceutica, Università di Milano, Milano, Italy, K.M. Samaria(*) and L.M. Vallarino, Virginia Commonwealth University, Richmond, VA 23284. Complexes of symmetrically di-substituted macrocyclic ligands, $C_{22}H_{24}N_6(X)_2$, can be synthesized by the lanthanide-templated 2:2 Schiff-base condensation of 2,6 diacetylpyridine and a carbon-substituted 1,2-diaminoethane, $NH_2-CH_2-CH(X)-NH_2$. These complexes can exist as two constitutional isomers, depending on whether the two -X substituents are adjacent to the same pyridine bridge-head or to opposite pyridines. Stereoisomers are also possible owing to the chirality of the carbon-substituted diimine side-chains. A study using La(III) acetate and (S)-1,2-diaminopropane as one of the precursors gave the two expected constitutional isomers in approximately 1:1 ratio, while the (R,S)-diamine gave three isomers in ratios that depended on the experimental conditions. The isomeric complexes were distinguished by their different proton nuclear magnetic resonance spectra and were separated by fractional crystallization. Substitution of the acetate counterions by thiocyanates gave well formed crystals for the isomers containing the (S,S)-5,15 and (R,S)-5,15 dimethyl-substituted macrocycle; their X-ray crystal structures are presented. (Supported by Coulter Electronics, Hialeah, FL, Virginia Commonwealth University, Richmond, VA, and N.A.T.O. Bilateral Project No. 184-85.)

ISOLATION OF PHENYLPROPANOID GLYCOSIDES FROM *POLYGONUM PENSYLVANICUM*. Laverne L. Brown, Michael L. Zimmermann, and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. The isolation of the protein kinase C inhibitors, vanicoside A and vanicoside B, from *Polygonum pensylvanicum* prompted continued interest in the active principles of this plant. A new, more efficient isolation procedure has been developed to facilitate separation of homologues of vanicosides A and B from the complex extract. This procedure involves the use of preparative hplc to concentrate principles of interest into less complex fractions, followed by the use of preparative TLC for final purification. This has resulted in the isolation of two new phenylpropanoid glycosides. The structures of these principles are being determined using ^1H , ^{13}C , and two-dimensional NMR techniques. The results of these investigations will be discussed.

CHEMISTRY AND OTHER HANDS-ON ENGINEERING AND SCIENCE IN A SUMMER CAMP FOR GIRLS. Kathleen Brunke, Biology, Chemistry, and Environmental Science; Shelia Greenlee*, Psychology; and Lynn Lambert, Physics and Computer Science, Christopher Newport University, Newport News, VA 23606. A three-week, semi-residential, summer science camp for 24 middle school girls at Christopher Newport University included a variety of activities, including field trips; career counseling; visits from local scientists; engineering and technology sessions; and hands-on science activities. The NSF-supported project was intended to encourage girls to consider science as a career; the science activities were therefore central to the program. Christopher Newport University female professors in Biology, Chemistry, Mathematics, and Physics led the fourteen hour and a half hands-on science sessions with topics ranging from binary numbers to comparing human and dinosaur stride length to designing a solar home. Chemistry sessions included measuring greenhouse gases, Chemistry and food, and making polymers. In each session, concepts were taught by doing. For example, in the "Greenhouse Gases" session, girls measured methane from wetland plants and from their own breath and talked about greenhouse gases (including the role of methane) thus learning about the greenhouse effect, the ozone hole, and the importance of wetlands. In "Polymers," they made gak, learned the recycling symbols, and looked at the detrimental effect of household solvents on some polymers. In the "Food Chemistry" session, they made ice cream to demonstrate freezing point depression. Evaluation of the project indicates that knowledge of and interest in science increased significantly as a result of the camp. Anecdotal evidence given by the girls and their parents in two follow-up sessions strongly supports these results. (This work supported by NSF grant number HRD-9453678)

PREPARATION OF DERIVATIVES OF VANICOSIDES A AND B, PHENYLPROPENOID GLYCOSIDES FROM *POLYGONUM PENSYLVANICUM*. Jean-Michel Campagne and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. Vanicosides A and B, two phenylpropenoid glycosides isolated from *Polygonum pensylvanicum*, were shown to inhibit the activity of protein kinase C, an enzyme involved in cell proliferation. These glycosides are characterized by the presence of three *p*-coumaroyl esters and one feruloyl ester on a sucrose backbone. In order to begin to determine the structure activity relationships in this family of glycosides, a series of derivatives of the glycosides are being prepared. Both an octaacetate derivative and a heptaacetate derivative have been prepared. Selective acetylation of the hydroxyl moieties present on the sucrose backbone and selective methylation of the phenolic groups are being explored. Hydrogenation of the conjugated double bonds of the phenylpropenoid groups proceeded smoothly. The conditions for and results of these conversions will be discussed.

CONVERSION OF ISOFLAVANONES INTO ISOFLAVONES BY Pd CATALYZED DEHYDROGENATION. Jean-Michel Campagne, Jennifer L. Dubois, Yodit Geberemedhin, and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. Seven isoflavanoids have been isolated from the Peruvian plant *Swartzia polyphylla* in our laboratory. Of these, only the isoflavone biochanin A proved to inhibit the activity of protein kinase C. The major difference between biochanin A and the other isoflavanoids was the C-2,3 double bond found in biochanin A. To determine if this double bond was required for inhibition of protein kinase C activity, we have attempted to convert the isoflavanones into isoflavones using Pd catalyzed dehydrogenation. The reaction works smoothly on those isoflavanones which do not contain a 2'-phenol, but fails on those isoflavanones which do contain this moiety. To further explore the requirements for this dehydrogenation, several isoflavones have been converted to the corresponding isoflavanone. These isoflavanones will then be converted back into the isoflavone by Pd catalyzed dehydrogenation. The conditions for and results of these conversions will be discussed.

QUANTUM MONTE CARLO SOLUTION OF ONE-DIMENSIONAL POTENTIALS: INVERSION OF NH_3 . Charles M. Castevens and Donald D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond VA 23284-2006.

A brief review of recent developments in the calculation of very accurate energies and properties of molecules, including transition states, using electronic Quantum Monte Carlo methods is presented. A one-dimensional Electronic Diffusion Monte Carlo method is used to solve the double-well potential for NH_3 , yielding good agreement with the known analytical solution within the context of a non-variational energy value and a statistical variance. Hartree-Fock-Roothaan SCF energies are also given in a multi-zeta STO-6G basis for C3v NH_3 (-56.18988997 au) and D3h NH_3 (-56.18651139 au) giving an estimate of the inversion barrier of 2.12 kcal/mole.

THREE-IN-ONE POLARIMETRY EXPERIMENT FOR PHYSICAL CHEMISTRY LABORATORY. Kelly Christopher and Donald D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond VA 23284-2006.

An experiment is described which measured (1) the kinetics of sucrose hydrolysis, (2) purity of commercial sucrose and (3) magnetically induced optical activity (Faraday Effect). A vernier degree ring (readings to ± 0.1 degree) from an earlier model (No. 7025) was adapted to a Griffin polarimeter. Richfood sugar was found to be 92-98 % sucrose $\pm 3\%$. The Nestler tube pathlength was uncertain by 2.7%. The solenoid was found to average 245 gauss along a 15 cm path at 12 amperes by calibration with pure CS_2 , as given by Pedrotti and Bandettini in Am. J. Phys. v58, p542, (1990). Neat methyl salicylate and N,N-diethyl aniline allowed measurable Faraday rotations and were transparent for use of human-eye detection. Aqueous NaI and KI solutions produced linear dependence of Faraday angle at 4M, 3M and 2M.

THE INFRARED SPECTRA OF VOCl_3 AND POCl_3 AT MODERATE RESOLUTION

Thomas C. DeVore, Dept. of Chem., James Madison Univ., Harrisonburg, VA 22807

The infrared spectra of the VOCl_3 and the POCl_3 gaseous molecules have been obtained from 4000 to 400 cm^{-1} at 0.125 cm^{-1} resolution. Previously unobserved isotopic structure was observed for ν_1 and isotopic structure was partially resolved for ν_2 and ν_4 . Several overtone and combination frequencies that were identified by using high sample pressures. Analyses of these bands enabled the harmonic frequencies for the fundamentals and several of the anharmonic correction constants to be determined. A revised symmetry adopted force field calculated using the harmonic frequencies indicated that the bonds in these molecules are slightly stronger than the force fields presented by Filgueira had indicated..

A NEW COMPETITIVE ENZYME IMMUNOASSAY OF (+)-CATECHIN IN HUMAN BLOOD SERUM.

Jay Fedorowicz, James Yuan and Roy Williams, Old Dominion University

Enological Research facility, Dept. of Chemistry/Biochemistry, Old Dominion Univ., Norfolk,

VA 23529. (+)-Catechin is the parent compound of a very special class of polyphenolic agents

found in a variety of fruits, seeds, wine and tea. These polyphenolics have been described as

potent free radical scavengers or natural antioxidants and are considered as positive health

factors in the human diet. High pressure liquid chromatography (HPLC) is the most common

method used for the quantification of (+)-catechin levels from natural sources. This paper will

describe the development of a new competitive enzyme immunoassay method (EIA), which is

very sensitive and offers considerable advantages over HPLC. The paper will describe the

method used to develop the polyclonal antibody to a newly synthesized immunogen from (+)-

catechin. The method has been shown to quite effective with a detection limit of 10pM (+)-

catechin and very little cross reactivity with the epimer (-)-epicatechin. This new EIA method

is some 5 orders of magnitude more sensitive than the previously used HPLC method and should

be extremely helpful in the study of the absorption and protein binding of (+)-catechin *in vivo*.

ELECTROSPRAY IONIZATION FOR MASS SPECTROMETRY OF LARGE

MOLECULES, John B. Fenn, Joan Rosell, Dongliang Zhan, and

Jian-Ru Cao, Department of Chemistry, Virginia Commonwealth

University, Richmond, VA23284-2006. Electrostatic dispersion

of sample solution results in a fine spray of highly charged

droplets from which intact ions of very large and complex

molecules can be formed for mass spectrometric analysis. The

mechanism by which such ions are formed is still a subject

of much debate. Meanwhile, new results keep putting proposed

mechanisms on the defensive. We present some such results

and speculate on their mechanistic implications.

FUNGI DYNAMICS: DEGRADATION OF MODIFIED CELLULOSE FILM.

Christopher Foust,¹ Richard Mills¹ and Raphael

Ottensmire², Depts. of Biology¹ and Chemistry², Va. Commonwealth Univ., Richmond, Va. 23284. An alternative strategy is

needed for plastic degradation in landfills to replace ultra-violet, photodegradable plastics which undergo minimal ultraviolet

degradation due to mixing and additional layers of refuse applied to the surface which effectively arrests degradation. Cellulose

occurs in a significant proportion of most consumer plastics and numerous strains of fungi are capable of utilizing cellulose

as a carbon source. Fungi also persist in the upper and middle strata of landfills.

A novel cellulose-polyethylene blend polymer film was developed in the Chemistry Department of Virginia Commonwealth

University for degradative susceptibility to brown rot or cellulosic fungi. Naturally occurring fungi were harvested from decaying

wood and cultured on full nutrient agar until individual phenotypes developed. The discrete fungal morphs were removed and

repeatedly placed on new agar plates until pure fungal strains persisted. Individual strains were transferred to Bacteriological

agar with carboxymethyl cellulose as the only carbon source. Surviving fungi were subjected to an indirect cellulase assay to

confirm cellulolytic properties. Taxonomic identification included examinations with scanning electron microscopy and optical

microscopy, using the Saccardo system of classification. Prepared modified films were cut into 1mm sample discs and placed

on growth-phase fungal colonies and incubated at 30 °C. The polymer discs were transferred to new-growth colonies every 21

days. Series scanning electron photomicrographs documented physical degradation of the polymers when exposed to fungi over

time.

The results showed 100% surface area growth of low density polyethylene (LDPE) blended with cellulose (12:1 respectively)

by *Trichoderma viride* in 90 days. Extrapolation showed 100% growth coverage by *Gliomastix* sp. on blends of LDPE/cellulose

130:1, and 70:1, in 180 days. These data are conservative, and rates of growth can be increased substantially by the addition

of a nitrogen source and/or synergistic fungi. Incorporation of the properties of this polymer film to high-turnover packaging

such as barrier plastics and consumer food product containers would be a significant reducer of global landfill volume over

time.

A STUDY OF THE AGGREGATION BEHAVIOR OF OLIGOPEPTIDES WITH DRUGS M.Haratake, R.Zhao & R.M.Ottenbrite, Department of Chemistry, Virginia Commonwealth University

We characterized the self-aggregation and the subsequent sphere formation behavior of the acid tri- and tetrapeptides (pyroEE(α)F, pyroEE(γ)F and pyroEE(α)F(γ)F) by light scattering and light microscopy. The tripeptides did not produce aggregates up to 0.1 M at pH 2. On the other hand, pyroEE(α)F(γ)F aggregated at relatively low concentration (11.8 mM). The pyroEE(α)F(γ)F associated with the drug molecules, such as insulin and bovine serum albumin, below the concentration at which the aggregation occurred. Whether the pyroEE(α)F(γ)F was associated with drugs or not, the same concentration of unassociated pyroEE(α)F(γ)F was necessary to achieve aggregates. Only the pyroEE(α)F(γ)F produced spheres in the presence of protein drugs tested.

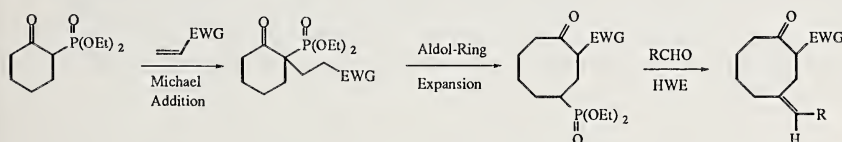
CATALYTIC ASYMMETRIC CYCLOPROPANATION BY CHIRAL METAL SALEN COMPLEXES. H. Brooks Hooper & Marcia B. France, Dept. of Chem., Washington and Lee Univ., Lexington, Va. 24450. The cyclopropane functionality is of great importance to organic chemistry. Found in a variety of natural compounds and of utility in many synthetic organic pathways, asymmetric cyclopropanes have generated widespread interest. This interest has manifested itself in a variety of asymmetric cyclopropanation catalysts. These existing catalysts have proved very effective for many reaction schemes, but a catalyst system with broad substrate generality affording high enantioselectivity remains unknown. The literature describes the preparation of several chiral rhodium(III) porphyrin complexes, but these catalysts display only moderate enantioselectivity. The salen ligand is structurally similar to the porphyrin, but possesses chiral centers closer to the coordination site, potentially affording greater stereochemical control. Several rhodium and copper salen complexes have been prepared and their ability to catalyze the desired reaction is currently under investigation. These preliminary studies have, to date, been carried out with readily available and less expensive salen derivatives.

ADSORPTION OF ZINC AND LEAD ON ALUMINIUM OXIDE AT VARIOUS pH AND IONIC STRENGTH. Anael Kimaro and Wing H. Leung, Dept. of Chemistry, Hampton Univ. Hampton, VA 23668. The adsorption of trace elements from the aquatic environment is controlled by processes that occur at the solid / liquid interface. Adsorption of zinc and lead from dilute solutions onto aluminium oxide has been investigated as a function of pH and ionic strength. The result of the adsorption experiments were fitted to Langmuir and Freundlich isotherms. Over the pH range studied (pH 5-8) results suggest that adsorption of zinc and lead onto aluminium oxide increases with pH and decreases with increase of ionic strength. Adsorption mechanism is also briefly discussed.

NEW ANGLES IN AEROSOL ANALYSIS. Pavel Kiselev, Joan Rosell and John B. Fenn, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. In many volatile aerosols one desires to track experimentally the composition of an evaporating droplet. We have developed a probe which allows the very rapid sampling of charged volatile droplets at various positions in a spray. The sampled liquid is then analyzed, for example by Gas Chromatography or Mass Spectrometry. Sprays of chloroform-acetone and of chloroform-alcohol mixtures have been studied. Enrichment of the less volatile component is found, indicating rapid mixing within the droplet. Although the present experiments depend on electrostatic forces to drive droplets to the probe, one could achieve equivalent results with inertial "forces".

RING EXPANSION REACTIONS OF ORGANOPHOSPHORUS COMPOUNDS. Sherry R. Kite and Suzanne M. Ruder *, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006.

Highly functionalized medium sized rings are commonly found in the structures of many natural products that possess biological activity. The intent is to develop new methodology for synthesizing medium sized rings from smaller ring precursors containing a phosphonate functionality. Addition of a side chain via Michael addition, followed by incorporation of the side chain into the ring results in ring expansion to provide a medium sized ring. These ring enlarged products containing a phosphonate group, could subsequently be transformed to an alkene by the Horner-Wadsworth-Emmons (HWE) reaction, to provide the carbon framework of a number of natural products.



COMPARATIVE PREPARATION OF ZINC OXIDE NANOPARTICLES. Shoutian Li*, M. Samy El-Shall and S. Silvers, Dept. of Chem., Va. Commonwealth Univ., Richmond, Va. 23284-2006. The ZnO nanoparticles were prepared by wet chemical method and laser vaporization/condensation technique. In the wet chemical method, the ZnO nanoparticles were coated with a monolayer of stearic acid molecules. The crystal structure of ZnO nanoparticles is same as the bulk ZnO crystal. The particles are spherical and about 10 nm in size. Quantum size effect is observed in the UV-vis spectra of the samples prepared by the wet chemical method. The photoluminescence spectra show the bandgap emission (380 nm) and trap state emission (520 nm). In the trap state emission, the lifetime depends on the emission wavelength, i.e., longer the emission wavelength, longer the lifetime.

THE PREPARATION OF WEBLIKE AGGLOMERATION OF SILICON NANOPARTICLES AND THE STUDY OF THEIR OXIDATIVE PROPERTIES BY FTIR. Shoutian Li* and M. Samy El-Shall, Dept. of Chem., Va Commonwealth Univ., Richmond, Va. 23284-2006. The Silicon nanoparticles were prepared in a diffusion cloud chamber by laser vaporization/condensation. The Si nanoparticles form weblike agglomeration in three dimensions and are about 10 nm in size. The FTIR spectrum of the as-deposited sample shows three IR bands: 1100 cm^{-1} (very strong), 887 cm^{-1} (weak) and 460 cm^{-1} (strong). The oxidation of the as-deposited sample can be achieved by either storing the sample in air or heating in an oven. As the sample is oxidized, the 887 cm^{-1} peak disappears, and the 800 cm^{-1} peak is generated and both the 1100 cm^{-1} and 460 cm^{-1} bands shift to higher energy vibrations.

AN INVESTIGATION ON THE INTERACTION OF HEPARIN WITH AROMATIC COMPOUNDS, J. Liao ^(a), R. Zhao ^(a), J. N. Scarsdale ^(b), S. Milstein ^(c) and R. M. Ottenbrite ^(a) (a) High Technology Materials Center, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284; (b) Department of Biochemistry and Molecular Biophysics, Medical College of Virginia, Virginia Commonwealth University, Richmond, VA 23298; (c) Emisphere Technologies, Inc., 15 Skyline Drive, Hawthorne, NY 10532. Heparin is well known for its therapeutic use as an anticoagulant agent. Clinically it has to be administered via injection since the molecular structure, along with its biological activities, is sensitive to the components in the gastrointestinal tract. Recently a number of low molecular weight aromatic compounds were found to facilitate transport of heparin across the gastrointestinal epithelium and facilitated the oral delivery of heparin to rats and primates. In this work, the interaction of heparin with the aromatic compounds was investigated by using heparin affinity chromatography, equilibrium dialysis, circular dichroism and two-dimensional NOESY spectroscopy. It was observed that the interaction of heparin with the aromatic compounds is mainly hydrophobic and may induce a change in heparin conformation.

GAS PHASE REACTIONS OF IONIZED AROMATICS CONCERTED WITH OLEFIN DIMERIZATION. Yezdi B. Pithawalla, M. Meot-Ner (Mautner), J. Gao and M. Samy El-Shall. Dept of Chemistry, Virginia Commonwealth Univ, Richmond., Virginia 23284.

Rates of endothermic charge transfer reactions are enhanced by orders of magnitude when concerted with covalent bond formation. The ionization potential of toluene (T) is lower than that of the isobutene (I) by 0.3 eV, hence direct charge transfer from T^+ to I is endothermic and has a reaction efficiency of $\leq 10^{-5}$. However, the overall exothermic three-body reaction of charge transfer concerted with condensation, $\text{T}^+ + 2\text{I} \rightarrow \text{I}_2^+ + \text{T}$ is observed with an efficiency that is enhanced, in comparison, by a factor of 10^3 , leading to nominal second-order forward rate coefficients of $5 - 25 \times 10^{-11} \text{ cm}^3 \text{ s}^{-1}$. Unusual pressure effects imply that after the excited complex $(\text{T}^+\text{I})^*$, a collisionally stabilized intermediate complex (T^+I) is formed, which undergoes unimolecular rearrangement to a covalent adduct, in competition with a reaction giving I_2^+ . Concentration effects along with temperature and simulation studies also support the formation of the collisionally stabilized intermediate complex. Potential applications involve understanding anodic electrochemical polymerization of olefins, channeling chemical reactivity and photo-induced initiation in the condensed phase.

A NEW APPROACH TO THERMODYNAMICS. L.J. Sacks, Dept. of Biol., Chem. and Environ. Sci., Christopher Newport Univ., Newport News, VA 23606. Accepting the definition of "energy" as the ability to do work changes the entire structure of thermodynamics theory, allowing three sequential Principles to replace the current three unrelated Laws. These reflect the experience that (1) Energy transfer is quantitative; (2) All processes are accompanied by a loss of energy; and (3) The energy required to displace a system from equilibrium is proportional to the displacement. Implementing the first principle is the recognition that work can only be done on a second system (which can be considered the reference system for determining the energy transfer), hence energy is not a property of any system but of the system, the surroundings with which it is to interact, and the nature of the energy transfer process. This approach conflicts directly the concept of energy conservation and eliminates the need for an entropy function, substituting directly driving forces of temperature, pressure of field differences; development is similar to that for electrochemical potentials.

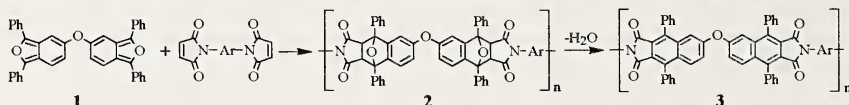
MAGNETIC CIRCULAR DICHROISM OF MELATONIN IN HELICAL POLY-L-GLUTAMATE. Alexis Warner, Charles M. Castevens, P. Ross and D. Shillady, Department of Chemistry, Virginia Commonwealth University, Richmond VA 23284-2006.

Recent discovery of a G-protein receptor for melatonin by Morgan and the tertiary structure of seven (nearly parallel) alpha helices common to G-protein structures led to consideration of measuring the MCD of melatonin in a solution of known helices. CD and MCD spectra of melatonin in solutions of Poly-L-Glutamate of 15,000 M.W. proved to be so characteristic of alpha-helix that data processing of up to eight spectral scans could not determine separate features due to melatonin. Improved calculations using a STO-6G** basis in the GAMESS program permitted geometry optimization of melatonin in the presence of eight water molecules to within $8.0E-6$ hartrees/bohr. A CNDO/S-D calculation using 99 single-excitations produced MCD band assignments with correct signs at 318 nm (amide n-pi*), 287 nm and 253 nm in qualitative agreement with experiment.

3-METHYLINDOLE DIMERS WITH ALKYL SULFONIC ACIDS. Wayne M. Stalick and George W. Mushrush, Dept. of Chem. George Mason Univ. Fairfax, VA. 22030. Diesel fuels contain small amounts of polar nitrogen, oxygen and sulfur compounds, and many of these have been implicated in the storage instability of fuels. Analysis of various middle-distillate fuel extracts has shown that the fraction which forms the most sediment contains the largest concentration of alkylindoles. It has been proposed that sediment formation results from the interaction of the heterocyclics with acids in the fuels. 3-Methylindole, when added to a fuel, was found to be a good promoter, whereas other nitrogen heterocycles such as 2,5-dimethyl quinoline and 2-picoline were innocuous. Analysis of the sediments show no incorporation of carboxylic acids, however, sulfonic acid incorporation is quite evident. The sediments formed from 3-methylindole and dodecylbenzene sulfonic acid (DBSA) are quite similar to insolubles formed in diesel fuel and appear to be dimers of 3-methylindole complexed to DBSA. Determination of the structure was difficult so 3-methylindole was also reacted with *p*-toluene sulfonic acid and *p*-ethylbenzene sulfonic acid to give similar but less complex products for structural analysis.

PHYTOCHEMICAL INVESTIGATION OF *POLYGONUM PERFOLIATUM*. Xingzhong Sun, Michael L. Zimmermann, and Albert T. Sneden, Dept. of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. The isolation of the protein kinase C inhibitors, vanicoside A and vanicoside B, from *Polygonum pensylvanicum* prompted investigation of extracts of other *Polygonum* species for related compounds. One of these species is *Polygonum perfoliatum*, also known as speed weed or mile-a-minute plant. Examination of the hplc chromatogram of the extract of *P. perfoliatum* indicated that phenylpropanoid glycosides related to the vanicosides should be present in this plant, the active principles of this plant. The extract was fractionated by standard chromatographic techniques. This resulted in the isolation of the known steroid, β -sitosterol, as well as several more polar principles. The structures of these principles are being determined using ^1H , ^{13}C , and two-dimensional NMR techniques. The results of these investigations will be presented.

AN APPROACH TO POLYIMIDE SYNTHESIS VIA DIELS-ALDER POLYMERIZATION OF A BISISOBNZOFURAN AND VARIOUS BISMALEIMIDES. Kent A. Watson and R.G. Bass, Dept. of Chemistry, Box 842006, Virginia Commonwealth Univ., Richmond VA 23284-2006. As part of a continuing program to develop high performance/high temperature polymers for potential use as composites and adhesives in various aerospace applications, an approach towards polyimide synthesis via a Diels-Alder reaction was investigated. A novel bisdiene, 5,5'-oxybis(1,3-diphenylisobenzofuran) (**1**) was synthesized and reacted with various bismaleimides via the Diels-Alder reaction. The resulting product **2** was dehydrated using a catalytic amount of sulfuric acid resulting in the fully aromatic system **3**. Low molecular oligomers were formed by this process as evidenced by inherent viscosities ranging from 0.15 - 0.17 dL/g for the dehydrated products. Despite low molecular weight products being formed, the materials exhibited enhanced solubility characteristics, presumably due to the incorporation of pendant phenyl groups along the oligomer backbone. This method of polymerization potentially avoids the formation of a polyamic acid intermediate, thereby eliminating the processing problems associated with the conventional method of polyimide synthesis. Optimization of this reaction to produce higher molecular weight polymers is currently being investigated.



TRANS AND CIS-RESVERATROL: THEIR POTENTIAL BIOLOGICAL ACTIVITY. R.L. Williams, and Mark Elliott, Old Dominion University Enological Research Facility, Dept. of Chemistry/Biochemistry, Old Dominion University, Norfolk, VA. 23529. The phytoalexin known as trans-resveratrol (trans-3,4',5'-trihydroxystilbene) has been described as an effective natural antioxidant found in low concentrations in red wine. We have now shown that this compound is also a potent anti-estrogenic agent. This estrogenic activity is associated with the compound's ability to bind effectively to both the type I and the type II estrogen receptors. An examination of the structure activity relationships(SAR) of trans-resveratrol and other estrogenic agents will be discussed together with information that would suggest that certain of the estrogenic activity may be due to a rapid equilibrium between the trans and cis forms of this compound. Information from a molecular modeling study of these two agents and other estrogenic agents will be presented.

SYNTHESIS OF POLYMETHYLSILOXANE PARTICLES (I) UNHYDROLYZED ETHOXIDE GROUPS ON POLYMETHYLSILOXANE PARTICLES R. Yin, R. M. Ottenbrite, Dept. of Chem, Va Commonwealth Univ., Richmond, Va 23284, J. A. Siddiqui, ICI Film, Bermuda Hundred, Hopewell, Va 23860, A simple approach was explored in our laboratory to achieve the synthesis of hybrid particles by using methyl triethoxysilane(MTEOS) as a monomer. The TGA traces of MTEOS particles indicated that three weight loss regions were related to three distinctly different reaction processes. The first weight loss was ascribed to the alcohol condensation of unhydrolyzed ethoxide groups which was directly affected by ammonia concentration and r-value ($r=H_2O/Si$). There was a large amount of unhydrolyzed ethoxide remaining in the MTEOS particles when a low ammonia or water concentration was employed in sol-gel process. Dehydrolysis rate was more dependent upon the r-value than the ammonia content in reaction system. The average number of unhydrolyzed ethoxide group is approximately 1 per parent silicon atom. The unhydrolyzed ethoxide groups may be attributed to reesterification.

AN INVESTIGATION OF OLIGOPEPTIDES INTERACTION WITH HEPARIN. R. Zhao, M. Haratake & R. M. Ottenbrite, Department of Chemistry, Virginia Commonwealth University, Richmond, VA 23284-2006. Based on a proteinoid microsphere oral drug delivery system reported earlier, several series of specifically sequenced oligopeptide trimers and tetramers were synthesized and their interaction with heparin, a popularly used anticoagulant, were investigated. It was found that one of the oligopeptide tetramers, which contains aromatic rings, was bound to heparin stronger than the others at low pH. Further research indicated that this interaction is due to H-bonding and hydrophobic interactions. Currently, this carrier is being tested *in vivo* with heparin.

Computer Science

VIRTUAL REALITY MODELING LANGUAGE. Peter R. Clark, Department of Computer Science, Mary Washington College, Fredericksburg, VA 22401. Virtual Reality Modeling Language (VRML) is an object-oriented programming language designed to bring a three-dimensional interface to the World Wide Web. The current version (1.0) of the language provides a means to both define static objects within a three-dimensional scene and link these objects to other files on the Internet. These scenes are displayed and browsed using either VRML-specific browsers, or plug-ins for current HTML browsers such as Netscape. Users can design worlds either by coding VRML with a standard text-editor or by using a 3D modeling program that supports the VRML 1.0 file type.

Liquid Reality, designed by Dimension X, Inc., is a set of Java classes that programmers can use to extend VRML beyond its original specification. Users may animate objects, handle events, and even create multi-participant scenes. To date, VRML has been used in creating both recreational and informational environments, such as Worlds, Inc.'s AlphaWorld; users may walk around a virtual community with the ability to interact with other citizens and even build virtual homes.

INTERFACING POLAROID SONAR SENSORS TO A 6.270 MICROCONTROLLER BOARD.

Dan Werner, & Dr. Rhonda Eller-Meshreki, Department of Computer Science, Randolph-Macon College, Ashland, VA 23005. We began building an interface between a Polaroid sonar transducer and a 6.270 microcontroller board with a 68HC11 microprocessor chip. We initially chose Interactive C to create programs that would drive the sonar transducer. However, the low-level details of interacting with this hardware conflicted with the internals of the Interactive C package. Therefore, we began writing 68HC11 assembly programs which could deal with the low-level details of the hardware in assembly but interface with Interactive C programs through function calls. We wrote assembly code using the 68HC11's Input Capture mechanism with a bumper sensor to simulate receiving the sonar echo. This was accomplished by tying the code for polling the bumper sensor to the Interactive-C system interrupt. Whenever the bumper was pressed, the time of this action would be saved in a hardware register. This register could be checked later to find out how much time had elapsed from the start of the program execution to the time recorded when the bumper was pressed. This mechanism can be used for determining the time that a sonar transducer echo was received by hardware. This time can then be used to compute the distance of the object from which the echo signal reflected. We will present the details of the simulated sonar echo and our ideas on how we hope to overcome the difficulties encountered with the physical sonar transducer during our work.

A SERIAL INTERFACE FOR A WORTHINGTON BAR CODE READER AND A 6.270

MICROCONTROLLER BOARD. Adam Rabung, Department of Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, VA, & Dr. Rhonda Eller-Meshreki, Department of Computer Science, Randolph-Macon College, Ashland, VA 23005. The robot that we considered is a LEGO robot controlled by an MIT 6.270 microcontroller board using the Interactive C programming language. The goal of this project was to program a full serial interface between these two hardware devices. Serial communication between the microcontroller board and the laser barcode reader can be done using either interrupt-driven methods or polling. With polling, the software continuously checks its serial port to see if any data has been scanned by the bar code reader. While this is simpler to program, it is restricting in that the processor is wasting a lot of time in a tight loop waiting to receive data. This approach is generally avoided by operating systems and modem communication software. Instead, they generate an interrupt to the processor when data arrives so that the processor can stop other tasks immediately when there is data to be handled. We began with a polling technique, due to its simpler nature. Using this technique we were able to successfully scan several character bar codes into the robot's microcontroller memory using 68HC11 assembly programs called by higher level Interactive C programs. However, we soon found timing difficulties with longer bar codes due to characters overrunning one another at the serial port of the microcontroller board. We will discuss the details of constructing our polling serial interface and address how we hope to overcome the difficulties that arose in our work.

Education

EXPLORING THE RATE OF CHANGE OF THE EXPONENTIAL FUNCTION: A PRECALCULUS PERSPECTIVE, Brian Bradie, Dept. of Mathematics, Christopher Newport Univ., Newport News, VA 23606-2998.

An activity has been designed which allows Pre-Calculus students to explore the key mathematical property which gives rise to the appearance of exponential functions in applications, namely, that the value of an exponential function changes at a rate proportional to its value. The introductory part of the activity develops the concepts of average rate of change and instantaneous rate of change for a function and also presents a procedure for calculating each quantity. In particular, a straight-forward graphical procedure for determining instantaneous rates of change is described. The second half of the activity then leads students through an exploration of the instantaneous rate of change of the exponential function. The exercises contained in this latter half of the activity divide into two categories: exploration exercises and algebraic/proof exercises. The exploration type exercises make use of graphing calculators and computer software and are designed to allow students to formulate hypotheses. The algebraic/proof exercises are intended to place the use of technology in proper perspective: calculators and computers are excellent tools, but students must learn that technology can never replace mathematical reasoning and skills.

AN INQUIRY-BASED APPROACH TO GENERAL BIOLOGY CURRICULUM: AN OVERVIEW. Marion B. Lobstein, Associate Professor of Biology, NVCC-Manassas Campus, NVCC-Manassas Campus, 6901 Sudley Rd., Manassas, VA 22110. This presentation is an overview of a three-year National Science Foundation grant to revise general biology curriculum for community and two-year colleges. The proposal for this grant was developed by and is being administered through Biological Sciences Curriculum Study (BSCS). BSCS has been involved since the late 1950's in developing inquiry-based biology curriculum at the high school and later at the middle and elementary school levels. In the early 1990's BSCS staff developed the proposal for this grant in order to extend these efforts to the community and two-year college level. Biology faculty from community and two-year colleges from around the United States have been recruited to serve on a Design Team to assist in the development of this curriculum. The Design Team, of which Marion Lobstein is a member, met with BSCS staff in Colorado Springs, Colorado in June 1995 and again in January 1996 to begin development of this project. The teaching materials developed from these initial efforts have been field-tested by Marion Lobstein in her general biology courses at NVCC-Manassas Campus during the 1995-1996 academic year. This presentation focuses on the field-testing progress made to date and on the possible future direction of this new curriculum effort.

CHARACTERISTICS OF WOMEN SCIENTISTS: SCIENCE IN DIFFERENT VOICES. Juanita Joan Matkins. This qualitative study involved the discovery of the enabling factors in the life stories of six women scientists, for the purpose of determining how they persevered in science. Participants included a meteorologist, two astronomers, a geologist, a forensic pathologist, and a physicist/astronaut. Data were obtained through individual semi-structured interviews. The primary factors included their view held from childhood of their "possible self as a scientist," strong maternal role models, support of parents, and expectation of financial responsibility. Secondary factors included childhood opportunity to participate in activities outside the school setting, and single-sex schools. Potentially disabling factors included sexist aspects of some graduate schools and of professional life in science, paternalism of institutions, and living apart from husbands. Implications for bringing more females into the sciences included supportive families, freedom for out-of-school proportional reasoning experiences, the availability of single-sex schools, graduate programs which were more supportive of females, and strong female role models. Patterns of sexism in the stories of these women indicated the need for critical examination of assumptions about women and science. Recommendations for further study included examining the importance to young women of a cooperative versus a competitive environment in school and examination of the qualities of single-sex schools as well as comparisons of women scientists who went to single-sex high schools and colleges to those who did not.

CHEMISTRY 101 STUDENTS' VIEWS OF THE STATES OF MATTER. Pamela C. Turpin, Dept. of Chem., Roanoke College, Salem, Va. 24153-3794. Answers from students' laboratory data sheets and tests provide a look at the misconceptions of college students, who are non-science majors, about the structure of the states of matter. Student responses show that misconceptions remain even after experiencing first hand activities involving state changes in a laboratory setting. When asked to explain changes in state of different materials observed in the laboratory, many students were unable to communicate effectively their ideas. Those who did communicate well, often had glaring misconceptions about energy changes and the motion of molecules that occurred in the state changes. This author suggests several reasons why this may be: difficulty of the concept, lack of communication skills on the part of students, picky laboratory instructor, time limitations of the pre-lab and laboratory periods, poor preparation in previous schooling, non-science majors work for grades not knowledge, science as a foreign language and the incorrect usage of terms by students, and students as "objects to be changed" and not as "participants in practice" in a community.

THE EFFECT OF STUDENT-PAID PORTION OF COLLEGE EXPENSES ON ACADEMIC ACHIEVEMENT AND PERSISTENCE AMONG COMMUNITY COLLEGE STUDENTS. Doris M. Velazquez, Debra L. Vendt, Maria E. Marscheider, Linda E. Miller¹, and James P. O'Brien, Social Sciences Div., Tidewater Cmnty. Col., Virginia Beach VA 23456 (and ¹SUNY, Old Westbury). Personal contacts with leaders in the field revealed that students' personal financial burden (SB) was considered (1) important, (2) extremely complex, (3) difficult to measure, (4) absent from the research literature, and (5) qualitative measures were recommended. Trials of the qualitative survey indicated that military and veterans (MV) students presented unique problems and a second version for these students was developed (MV data was not analyzed here). It was hypothesized that SB would be positively related to GPA and negatively related to Persistence (P) for community college students (N=79). As existing literature does support, r 's were significant for the Parental Non-Support measure \times GPA, $r = +.397$, and \times P, $r = -.308$, beyond .0005 and .005 levels of significance (1-tailed tests), respectively. More direct SB measures, however, must be rescored since the ranking devices used in these analyses appear to be too coarse, although some reached significance beyond the .05 level. This study apparently represents the first reported treatment of the effects of student-paid vs. parent-paid portions of college costs.

Environmental Science

PRELIMINARY ECOLOGICAL ASSESSMENT OF MASSAPONAX CREEK, SPOTSYLVANIA COUNTY, VIRGINIA. Michael L. Bass Department of Environmental Science and Geology, Mary Washington College and John Tippet, Friends of the Rappahannock, Fredericksburg, VA. The rapid urbanization of parts of Spotsylvania County has shifted attention of negative nonpoint source runoff into streams from agricultural to commercial and suburban development. Investigators using the Izaak Walton League, SOS protocol sampled a rural low impacted stream, Hunting Run, and an urbanization impacted stream, Massaponax Creek. Massaponax Creek exhibited higher sediment deposition, fluctuating pH, increased algal growth and decrease in quality macrobenthic habitat along its course to the Rappahannock River. Hunting Run showed significantly higher indices for sensitive macroinvertebrates while Massaponax Creek showed higher indices for somewhat sensitive and tolerant macroinvertebrates. Total Indice Values for Hunting Run was twice that of the downstream Massaponax Creek stations. Methods to improve water quality and decrease negative urbanization impacts are being pursued.

CLASSIFICATION OF FLUORIDE RELATED TOOTH LESIONS IN MULE DEER

(*Odocoileus hemionus*): A PROPOSED SIMPLIFIED SYSTEM. Luz M. Borrero and P. F. Scanlon, Dept. of Fisheries and Wildlife Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The primary method for rating lesions due to fluoride toxicity in ruminants is that of Shupe et al. 1963 (Am. J. Vet. Res. 24:964-979) which was developed for used mainly with cattle. In our experience evaluators have not been consistent in rating lesions in mule deer. Teeth from deer collected at the US Air Force Academy Colorado Springs, CO were evaluated using a modified Shupe et al. 1963 technique. The technique scored incisor lesions varying from 0 to 5 where 0 had no lesions and 5 had severe lesions with hypoplasia and hypomineralization of the enamel. Ten volunteers, sophomores majoring in wildlife science at VPI & SU, were trained to use the method. Scores of 0, 1 and 5 were less likely to be missed. In general, most volunteers tended to underestimate scores greater than 0 rather than overestimate scores. The proposed evaluating method concentrates on quantifiable characteristics related to the enamel lesion rather than on wear, staining and chipping which may be associated with age, diet and handling of samples. The proposed system may be more appropriate for use with smaller ruminants and be valuable for less experienced personnel in recognizing fluoride related problems. The system follows: *A Normal*; Normal shape and size; enamel smooth, translucent glossy white. *B Slight effect*; Lesions vary from light white spots, striations and/or mottling that involves less than 50 % of the tooth. *C Marked effect*; Same as *B* but the lesions involve more than 50 % of the enamel. *D Severe effect*; Along with mottling there is hypomineralization and hypoplasia of the enamel. [Funding: US Air Force, V.P.I. & S.U., Fulbright Grant and Encyclopedia Britannica.]

CONCENTRATION OF FLUORIDE IN BONE AND TEETH OF MULE DEER (*Odocoileus hemionus*) FROM COLORADO. Luz M. Borrero and P. F. Scanlon, Dept. of Fisheries and Wildlife

Sciences, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. In recent years mule deer at the US Air Force Academy (USAFA) at Colorado Springs, CO have shown unusual antler fractures and tooth lesions. Brittle bones and tooth lesions have been associated with ingestion of high fluoride levels in the diet. The purpose of the present project was to determine tooth lesions severity and its possible relationship to fluoride contents in teeth and bone. Jaw bones with teeth were recovered from deer at the USAFA (N=262), Piñon Canyon Maneuver Site (N=24, PCMS, Model, CO), and Game Management Units (N=16, GMU's, northwestern CO) between 1993 and 1995. Incisor lesions were scored from 0 to 5 using a modified Shupe et al. 1963 (Am. J. Vet. Res. 24:964-979) method. Fluoride concentrations were measured using an ion selective electrode. No differences among median tooth lesions were found in the three sites, but the highest rated lesions were found only at USAFA. The median concentrations of fluoride were higher in teeth and bone from deer at the USAFA than in those from other areas. Among deer from the USAFA teeth with lesions had higher concentrations of fluoride than those without lesions. Females had higher concentration of fluoride than males. Presence of tooth lesions in adult deer is indicative of high fluoride exposure but chemical analysis is necessary for objective analysis of a fluoride contamination problem. [Funding: US Air Force, V.P.I. & S.U., Fulbright Grant and Encyclopedia Britannica.]

A COMPARISON OF PHYTOPLANKTON COMMUNITIES IN THE MARY WASHINGTON COLLEGE MESOCOSM AND IN THE YORK RIVER. Virginia Clarke & Stephen Gough, Dept. of Biol. Sci., Mary Washington Col., Fredericksburg, Va. 22401. Advanced mesocosms have the potential of simulating natural sites, thus aiding basic research and potential impact assessment. Adequate proof of emulation requires rigorous tests of--among other things--biotic community comparability. In this study, phytoplankton diversity and density at both the York River, Virginia, and the Mary Washington College mesocosm were determined using small-mesh collecting nets and a Sedgwick-Rafter cell counting technique. Results showed vast differences between the mesocosm and the site, suggesting the former was not faithfully emulating the latter. Among the reasons for the lack of fidelity may be that the intermediate disturbance theory was operative at the natural site and not in the mesocosm. Also, the estuarine system we attempted to simulate is highly complex hydrologically and may not be amenable to mesocosm replication methods.

ZOOPLANKTON DYNAMICS IN AN ARTIFICIALLY DESTRATIFIED RESERVOIR, LAKE BARCROFT, FAIRFAX COUNTY, VIRGINIA. Theresa E. Connor and R. Christian Jones, Dept. of Biology, George Mason Univ., Fairfax, VA. 22030. Zooplankton dynamics in Lake Barcroft were investigated through bi-monthly sampling from May-October, 1995. Crustacean zooplankton were identified and enumerated from vertical tow samples collected with a 202 μ m mesh conical net. Animals identified were: Eurytemora affinis, Diaptomus pallidus, cyclopoid copepodid, harpacticoid copepodid, Daphnia pulex, Diaphanosoma brachyurum, Ceriodaphnia, and chydorid species. E. affinis was the dominant copepod with densities from 10-90 animals per liter with high densities in May-June and August. D. brachyurum was the dominant cladoceran with densities from 18-120 animals per liter with high densities in early June through early August.

NITROGEN AND CARBON LOSS TO THE ENVIRONMENT DURING STORAGE OF DAIRY CATTLE WASTE. James D. Cox, J. H. Herbein, & J. J. Loor^{*}. Dept. of Dairy Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Obtaining reliable estimates of nitrogen (N) and carbon (C) residue in dairy cattle waste storage facilities when the waste is scheduled for application to crop land requires knowledge of organic matter (OM) loss to the atmosphere during storage. Predictions of N and C kinetics in stored waste were estimated using feces and urine from 4 lactating cows. Feces (363 g), urine (130 g), and tap water (13 g) were mixed in 800 mL plastic containers designated for analysis after 0, 2, 4, 8, 16, or 32 days (d) of storage at 25 °C. Data from 28 containers at each d of storage indicated a linear decrease in total mass across time, with only 60% remaining at 32 d. The OM and C content also declined linearly, such that 63% and 64%, respectively, remained at 32 d. However, 95% of total N remained at 16 d, then declined to 67% at 32 d. Loss of N was from the liquid phase (separated by centrifugation at 20,000 x g) of the waste, with only 35% remaining in the liquid after a linear decline from 8 to 32 d. Ammonia-N was 25% of total liquid N at 0 d, then became the primary form of N (50 to 60%) in the liquid. Ammonia concentration in the liquid increased from 0 to 2 d, remained elevated until 16 d, then declined until 32 d. Loss of C during storage may be due to microbial fermentation of fecal OM, indicated by a decline in pH from 8.5 at 0 d to 6.5 at 8 d. The pH remained at 6.5 until 16 d, then increased to 7.5 at 32 d. Overall, results indicated loss of approximately 35% of N and C due to volatilization during the first month of dairy cattle waste storage. (Supported by funding from Virginia Agricultural Council, Project No. 282)

MONITORING CO₂ EVOLUTION FROM MERCURY TREATED FOREST SOILS. Andy P. Damalas, Dept. of Biol., Old Dominion Univ., Norfolk, VA. 23529. Greatest amounts of soil CO₂ evolution result from microorganismal activity. Ten-gram composite field soil samples were obtained from selected spots in forest stands, incubated in flasks and were allowed to evolve CO₂ for about 85 hours. A center-well in each flask contained 0.5 N NaOH absorbing the CO₂. Amounts absorbed were determined by a conductivity cell and conductivity bridge. Calibration curves and preliminary tests for standardizing the methodology were performed in the lab using field soils. Differences in the magnitude of change in CO₂ evolution were found and are believed to be indicative of the ability of sites to recover from certain stresses. Three mercury compounds-mercuric chloride (HgCl₂) mercuric oxide (HgO), mercuric sulfate (HgSO₄)-were chosen as possible heavy metal pollutants of forest soil ecosystems, i.e. possible airborne mercury compounds emitted from fossil fuel plants. Application of these mercurials to forest soils simulated mercury emissions from coal burning industries. All three chemicals were applied in powder form with sand to soil. Treatment with 128 ppm and 256 ppm HgCl₂ and 128 ppm HgO did not inhibit CO₂ evolution. Treatment with 256 ppm HgO and 128 ppm and 256 ppm HgSO₄ depressed CO₂ evolution. A methodology was developed and tested for rapidly, efficiently, and effectively monitoring amounts and rates of CO₂ evolution from soils. It may be also be useful for estimating ecosystem change, making robust comparisons of areas, and gaining information about ecosystem structure and dynamics from one integrating index. (Supported by grant from Center for Environmental Studies, Virginia Tech).

USE OF THE *IN VITRO* BRAINSTEM PREPARATION OF *RANA CATESBEIANA* IN THE DEVELOPMENT OF A PHYSIOLOGICALLY-BASED TOXICOKINETIC COMPUTER SIMULATION MODEL FOR LEAD-INDUCED NEUROTOXICITY RISK ASSESSMENT. Michael D. Druitt, James A. Wise, Edward G. Smith, Dept. of Biol., Hampton Univ., Hampton VA 23668. To date no complete paradigm exists that satisfactorily integrates both the proposed anatomical and functional substrates of lead-induced neurotoxicity. A series of studies was conducted using the *in vitro* brainstem preparation and the intact larval form of *Rana catesbeiana* to accomplish this goal, and therefore reduce the uncertainty in risk assessment for lead-induced neurotoxicity from exposure to low concentrations of lead. Our studies have shown that early stage larva exhibit a lower LC₅₀ for lead. The LC₅₀ for Group I (stages IX-XII) was 7.9 ppm versus 13.4 ppm for Group II (stages XIV-XVI) and Group III (stages XVII-XX). This corresponds to the increased sensitivity of young children to lead toxicity when compared to adults. The strategy of this project is to use this preparation to develop a physiologically-based toxicokinetic and a computer simulation model based on electrophysiological studies using the isolated brainstem preparation of *Rana catesbeiana*, toxicity studies using the intact larval form, and a quantitative structure activity relationship model (QSAR) for lead. These studies will ultimately result in the use of *Rana catesbeiana* as a sentinel species whose ventilatory responses to CO₂ can be monitored to signal potential lead-induced toxicity risk to other species, including humans.

A COMPARISON OF FORESTED AND NON-FORESTED RIPARIAN BUFFERS IN THE REDUCTION OF NONPOINT SOURCE POLLUTION IN THE UPPER RAPPAHANNOCK RIVER BASIN. Kristen Eberly and Michael L. Bass, Department of Environmental Science and Geology, Mary Washington College. Forested riparian buffers are excellent nutrient and sediment filters when adjacent to agricultural or urban sources of nonpoint source pollution and streams. A survey was sent to landowners on the Rapidan River in Orange County to determine awareness of the benefits of restoring and maintaining forested riparian zones, and of cost-share programs available to landowners to participate in land stewardship practices. Survey results showed 71% of landowners were willing to participate only with 50% government support. Water samples were taken from forested and non-forested feeder streams in an area on the Rapidan river in order to compare the uptake and filtering of nutrients in these two different zones. It was found that the streams in the forested riparian areas contained lower levels of phosphorus and nitrogen and also had lower hardness levels. Preliminary analysis of the macrobenthic community showed streams with adequate vegetated riparian buffer exhibited good macrobenthic community diversity. Forested riparian buffers are effectively filtering nonpoint source pollution from agricultural areas in the upper Rappahannock. Continued correspondence with landowners and further sampling in planned.

UPTAKE OF HEAVY METALS BY THE HALOPHYTE *Suaeda maritima*. Kimmara E. Evans, B.G. Shipes, and W. Leung, Depts. of Biology and Chemistry, Hampton University, Hampton, VA 23668. *Suaeda maritima* (L. Dum.), Family Chenopodiaceae is a succulent halophyte. This plant grows in high saline environments as well as some non-saline environments. The growth of this plant on a dredged disposal site has prompted research on the bioaccumulation of heavy metals in *S. maritima*. The purpose of this study is to determine whether *S. maritima* takes up and stores heavy metals. Samples taken from Craney Island Disposal Facility were separated into leaves, roots and stems, to test for the compartmentalization of the heavy metals, cadmium (Cd), lead (Pb), zinc (Zn), copper (Cu), and nickel (Ni). The samples were dried, ground, and digested in concentrated nitric acid. These solutions were diluted and then tested by atomic absorption spectroscopy for the indicated metals. Preliminary testing confirms the bioaccumulation of some of these metals in the test plant, allowing further testing to continue in determining whether or not this plant is a likely candidate for phytoremediation.

PHYSIOLOGICAL INDICATORS OF STRESS IN FISHES IN A UNIQUE MESOHALINE MICROCOSM SYSTEM. Heidi Ferrell & Stephen Gough, Dept. of Biol. Sci., Mary Washington Col., Fredericksburg, Va. 22401. A microcosm is a simulation of a natural ecosystem, and such tools are currently an area of intense research for studying complex community interactions. However, the validity of these systems is an issue of debate; therefore assessment of their accuracy is necessary before results can be extrapolated to the natural environment. This study examined fish stress levels in the Mary Washington College microcosm, an emulation of a mesohaline region of the York River, Virginia. Chronic stress was determined in the Atlantic silverside (*Menidia menidia*) using a hepatosomatic index (HSI). The data were compared to fish in the river and in a traditional experimental aquarium. HSI was consistently lower in the York River than in the microcosm, indicating chronic stress in the former. HSI was elevated in the aquarium population, suggesting exposure to specific stressor(s). The results seemed to support the intermediate disturbance hypothesis (IDH), and the microcosm may be simulating a climax (i.e., stable) community instead of a fluctuating, nonequilibrium environment like the York River.

BETA-GLUCOSIDASE AND DEHYDROGENASE SOIL ENZYME ACTIVITY AS AN INDICATOR OF DEGRADED SITE RECOVERY. Andrew C. P. Heaton, John R. Heckman & John Cairns, Jr., Dept. of Biol., Virginia Tech, Blacksburg, Va. 24060. To demonstrate the feasibility of using soil dehydrogenase activity as a gauge of the temporal recovery of damaged terrestrial systems, a section of land was degraded and parts of the site were restored using different seedings and amendments. After nine months of recovery, dehydrogenase activity was measured monthly for several of ten months. Initial dehydrogenase levels exhibited differentiation of only reference (undegraded) sites from all other sites. As recovery progressed, dehydrogenase levels differentiated among several treatment combinations, indicating a potential differential recovery among the treatment combinations. Amendment status was determined to be a more important variable than seeding type in effecting these differentiations. β -glucosidase enzyme activity was measured concurrently with the last two dehydrogenase measurements in order to draw a relationship between dehydrogenase activity and cellulose decomposition activity in the recovering plots. The two enzymes indicated substantial correlation to one another, though β -glucosidase appeared to be a more sensitive estimation of amendment status than dehydrogenase. Despite the complicating factor of possible seasonal variability in enzyme activity, these measurements demonstrated the potential utility of dehydrogenase and possibly β -glucosidase activity levels as estimations of soil recovery from disturbance events.

PRIMARY RESTORATION OF INDUSTRIALLY DEGRADED LAND: PRELIMINARY TESTS FOR CORRELATION BETWEEN INITIATED COMMUNITY STRUCTURE AND RETURN OF FUNCTIONAL CAPACITY. John R. Heckman, and John Cairns, Jr. Virginia Tech, Blacksburg, VA, 24061, USA. A primary concern with ecological restoration lies in the ability to determine the point at which a system has satisfactorily recovered. Common recovery indices center around the development of a macro-community structure similar to the predisturbance condition or another suitable reference. An alternative basis for measuring restoration efficacy is a comparison of ecological functions. To test this hypothesis, structural (vegetational community) and functional (CO_2 efflux, CH_4 uptake, cellulose decomposition rate and enzymatic activity) end-points are being observed on homogeneous, grassland soils treated with an array of reclamation treatments. Undisturbed, adjacent old field systems provide for reference comparisons. Recovering soils in 1995 showed a higher mean CH_4 uptake rate (mean = 1.9 g $\text{CH}_4\text{-C}/\text{ha}/\text{day}$, $\text{SD} = 0.3$) than reference soils (mean = 1.05 g $\text{CH}_4\text{-C}/\text{ha}/\text{day}$, $\text{SD} = 0.38$) with high seasonal variance. CO_2 efflux in reference soils was higher (mean = 48.9 kg $\text{CO}_2\text{-C}/\text{ha}/\text{day}$, $\text{SD} = 23.5$) than recovering soils (mean = 28.1 kg $\text{CO}_2\text{-C}/\text{ha}/\text{day}$, $\text{SD} = 11.7$). The developing trend shows treatments with higher soil organic matter amendment and more diverse seed mixes to be more functionally similar. Robust conclusions concerning reclamation treatment and similarity of functional capacity cannot yet be made. The study continues through 1996.

PHYTOPLANKTON DYNAMICS IN AN ARTIFICIALLY DESTRATIFIED RESERVOIR, LAKE BARCROFT, FAIRFAX COUNTY, VIRGINIA. SAIFUL ISLAM AND R. CHRISTIAN JONES, DEPT. OF BIOLOGY, GEORGE MASON UNIVERSITY, FAIRFAX, VA 22030. Lake Barcroft is artificially destratified through aerators during summer months to control blue-green algae which may form surface-scum in the lake. Sampling was done bi-weekly during may through october in 1995. Identification, density, and biovolume suggest that blue-greens still dominant in the lake during summer period especially Coelosphaerium naegelianum. Diatoms dominated biovolume levels in the fall. Greens were sporadic but were represented by more species than blue-greens.

INTER-ANNUAL TRENDS IN WATER QUALITY AT AN EMBAYMENT AND NEARBY MAINSTEM OF THE TIDAL FRESHWATER POTOMAC RIVER. R. Christian Jones & Dann M. Sklarew, Dept. of Biol., Geo. Mason Univ., Fairfax, Va. 22030-4444. From 1983-1994, water quality was monitored regularly in and around Gunston Cove, an embayment of the tidal freshwater Potomac River. Time-series analysis revealed no significant inter-annual trends ($P < 0.05$) in summertime surface water quality. Such trends may be obscured by abiotic factors, particularly the local flushing regime. To test this hypothesis, we examined the correlation between average (1- to 28-day) flow and major water quality parameters (chlorophyll A, N and P species) at two stations (cove, mainstem). Statistically significant flow correlation existed with total phosphorus, organic nitrogen, and chlorophyll A in the cove, and with ammonia in the mainstem. Best fitting curves were then used to derive flow-corrected residuals. Residuals' time-series failed to reveal any underlying linear changes at either site. Thus, while flushing contributes to temporal variability, it apparently has not masked any persistent inter-annual trends in the water quality of this system. (Supported by the Fairfax County Department of Public Works and the Interstate Commission on the Potomac River Basin.)

ASSESSMENT OF POINT-SOURCE POLLUTION IN STONY CREEK, VIRGINIA USING BENTHIC MACROINVERTEBRATES. Robert W. Louque & Brian C. Caldwell*, Biol. Program, Shenandoah Univ., Winchester, VA 22601. The study investigated whether discharge from a chicken processing plant affected the downstream benthic macroinvertebrate community. Methodology was adapted from the EPA's Rapid Bioassessment Protocol 111. Two sites--a mile upstream and a mile downstream of the discharge pipe--were assessed bimonthly for macroinvertebrates, temperature, dissolved oxygen and chloride ion concentration. Data were gathered seven times at each site. Although no significant differences using the Family Biotic Index and the EPT Index were found, two measures of community similarity indicated that macroinvertebrate diversity was indeed lower at the downstream site. Further examination of data revealed an absence of two chloride sensitive genera [Pteronarcys (Plecoptera) and Ephemerella (Ephemeroptera)] and had a significantly higher chloride ion concentration ($p=0.009$) at the downstream site. These genera were frequently found at the upstream site. Since the chicken plant uses ferric chlorides to kill bacteria, the discharge is possibly causing an impairment to the creek. Further study is recommended.

SEASONAL VARIATION IN THE ABUNDANCE OF MESOZOOPLANKTON IN THE LOWER CHESAPEAKE BAY. George Mateja, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, VA 23529. Monthly collections of mesozooplankton were carried out within the lower Chesapeake Bay mainstem from August 1985 to September 1995. Calanoids are the dominant zooplankton within the bay, making up 50 to 60 percent of the total zooplankton abundance, and cladocerans comprise 12 to 40 percent of the population. Seasonally, the zooplankton appear to have two periods of maximum densities; the initial occurring during the early spring (March to May), and the latter occurring during the fall (July to October). Three of the four stations display the primary abundance mode during the fall. The zooplankton community is reduced during the summer and the minima occur during the winter (November to January). This pattern is consistent for all the reported mainstem stations. Long-term trends indicate mesozooplankton abundance is declining at all the mainstem stations. Supported by Va. Dept. of Environmental Quality

SOIL CONTAMINATION AND ITS INFLUENCE ON TRACE METAL UPTAKE BY PLANTS AT CRANY ISLAND. Eshete, Matthewos*. Wing H. Lueng, Dept. of Chemistry, Hampton Univ., Hampton, Va. 23668. Barbara G. Shipes, Dept. Biology, Hampton Va. 23668. A study was conducted to correlate the contamination of soil at Crany Island with the heavy metal uptake by plants. Various concentrations of five heavy metals (Cu, Zn, Ni, Cd, Pb) were detected in the soil of Crany Island. These five heavy metals accumulated in different parts of *Phragmites communis* and *Spartina alterniflora* were also measured. Results suggest that metal uptake by these plants is closely related to the metal concentration in soil. Accumulation of heavy metals by these plants is also found to vary from each other. Generally *Phragmites communis* show higher accumulation of these five heavy metals.

REMEDIATION DIFFICULTIES ASSOCIATED WITH A LARGE HYDROCARBON PLUME LOCATED UNDER A DENSELY URBANIZED AREA IN NORTHERN VIRGINIA. Douglas Mose, Chemistry Department, George Mason University, Fairfax, VA 22030. Recently approximately 200,000 gallons of hydrocarbon fuels were discovered to have been lost into the soil below a fuel storage terminal in northern Virginia. The subsurface plume now extends more than 2000 feet into an adjacent business and residential community. The plume is about 500 feet wide, and rests on the local water table at depths of 20-40 feet. The low permeability of the soil has prevented rapid fuel removal and soil remediation. Soil evacuation will not be utilized because of the estimated cost and the disruption of the community. Less disruptive technologies have been evaluated, of which a combination of bioremediation and removal of contaminated groundwater has been selected. Estimates of remediation down to reasonably safe levels (less than 100 ppm Total Petroleum Hydrocarbon) are on the order of 20 to 200 years.

ZOOPLANKTON COMMUNITY ASSEMBLAGES AS BIOINDICATORS OF A STRESSED SYSTEM. Gyung Soo Park, Dept. of Biological Sciences, Old Dominion Univ., Norfolk, VA 23529. Micro- and mesozooplankton abundances were determined at five stations in the Chesapeake Bay and tributaries from January 1993 through December 1994. Principal component analysis was used to characterize the stations based on the nutrient loading, dissolved oxygen, water temperature and pH. The Elizabeth River stations were designated as highly stressed due to the high nutrient loading, low dissolved oxygen, high water temperature and low pH. Zooplankton composition in the highly stressed system (Elizabeth River stations) was significantly different from the moderately stressed system (Bay stations). Rotifers and aloricated ciliates were more abundant in the stressed water body. On the other hand, loricated ciliates, copepod nauplii and mesozooplankton showed high abundances in the moderately stressed system. Supported by Department of Virginia Water Quality and the EPA.

RECOVERY OF COMMUNITY STRUCTURE AND LEAF PROCESSING IN A HEADWATER STREAM FOLLOWING USE OF A PASSIVE TREATMENT SYSTEM TO ABATE COPPER POLLUTION. Alicia Slater Schultheis & A. C. Hendricks*, Dept. of Biol., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. Prior to treatment, copper concentrations ranged from 8.9 to 32.0 $\mu\text{g/L}$ at the impacted sites and from 0.1 to 7.7 $\mu\text{g/L}$ at the reference site. Insect abundance (n) and number of taxa (#) were reduced at the impacted sites (n = 31, 22, 33, 24 and # = 190, 246, 266, 345) relative to the reference site (n = 52, # = 973). Red maple (*Acer rubrum*) leaves broke down twice as fast at the reference site (k = -0.029) than at sites receiving the untreated effluent (k = -0.016, -0.013, -0.013, -0.013). Following treatment, copper concentrations at the impacted sites ranged from 0.1 to 14 $\mu\text{g/L}$. Functional recovery preceded recovery of community structure by at least six months. Decomposition rates were similar at all sites after six months of treatment (k = -0.012, -0.011, -0.011, -0.012, -0.012) Recovery of community structure was not complete after 1 year of treatment. Collector-filterers and predators recovered quickly following treatment, while recovery of collector-gatherers and shredders was slower.

A COMPARISON OF PERIPHYTON ON *RUPPIA MARITIMA* IN A MESOCOSM AND THE YORK RIVER. Timothy York & Stephen Gough, Dept. of Biol. Sci., Mary Washington Col., Fredericksburg, Va. 22401. Mesocosms can be useful tools to mimic natural sites for efficient analysis of basic ecosystem processes and impact potential. However, any given mesocosm must be validated as a model of the true location. One mechanism for accomplishing this is to examine the community structure of its various components. In this study, the community dynamics of periphyton existing on blades of *Ruppia maritima* were compared in a novel mesocosm and a mesohaline site on the York River, Virginia. Periphyton was removed using the standard F.A.A. wash method of Gough and Woelkerling (1976), and Sedgwick-Rafter (S-R) cell counting procedures were employed to obtain densities. Shannon and Simpson diversity indices and community structure were then determined. In community structure, the two systems did not emulate each other, but diversity indices were similar. It appears that while the two ecosystems were functional, they were not similar to each other, probably due largely to intermediate disturbance that was prevalent at the river.

Geography (No Abstracts Submitted)

Geology

THE MECHUM RIVER FORMATION IN ALBEMARLE COUNTY, VIRGINIA. C. M. Bailey, Dept. of Geology, College of William & Mary, Williamsburg, VA 23187. The Late Proterozoic Mechum River Formation crops out in a 0.5 to 2 km wide, NE-SW trending belt in the central Virginia Blue Ridge province. In the southern portion of the belt boulder conglomerates are overlain by arkosic sandstones. To the north, laminated metasiltstones and phyllites are overlain by arkosic sandstones. A greenschist facies foliation defined by aligned phyllosilicates and elongate detrital grains is common in the arkoses and phyllites. The Mechum River belt has previously been interpreted as a graben, half-graben, thrust-faulted inlier and structural infold. In Albemarle County the belt is characterized by a series of asymmetric northeast-plunging overturned folds. Both the southeastern and northwestern contacts of the belt dip moderately to the southeast. At the southeastern contact, Grenvillian basement is thrust over metasedimentary rock. The Mechum River Formation unconformably overlies Grenvillian basement at its northwestern contact. In its present geometry, the Mechum River belt is not a graben. Line-length restorations reveal between 40 and 70 percent shortening across the belt, but penetrative strains throughout the unit require greater than 100 percent total shortening. Cross section restoration of the Mechum River belt yields little information as to the original geometry of the depositional basin. Field relations and microstructures indicate that folding and metamorphism of the Mechum River belt predate thrusting along its southeastern margin.

GIV AND ABICAS (TM): EFFECTIVE SOFTWARE FOR DIGITAL GEOLOGIC MAPPING. C.R. BERQUIST, JR., Virginia Division of Mineral Resources, Dept. of Geology, College of William and Mary, Williamsburg, VA, 23187. GIV (Geologic Information Visualization) is a group of public domain computer programs that enable a user to view and create digital and paper maps on DOS (TM)-based PCs. Scanned geologic and topographic maps are displayed on the video monitor and points (lines) are entered with a mouse. Limited attribution of points, lines and areas is possible in GIV. Additional features, such as creating DRGs and autotracing ("autovectorizing") and the capability to define multiple attributes to spatial data is available in ABICAS, a commercial "upgrade" to GIV. Over the past two years we have digitally replicated over 30 published geologic maps (1:24,000) and are creating several new geologic maps by using this software. Productive work by individuals who are familiar with topographic and geologic maps and who use this software is achieved commonly with less than a day of training. Our digital data is in ASCII format and has been successfully imported to ATLAS-GIS (TM) and hence to ARC_INFO (TM).

STRATIGRAPHIC VARIABILITY OF RADON, SOUTHEASTERN VIRGINIA. C.R. BERQUIST, JR., Bruce K. Goodwin, and Stephen C. Clement, Dept. of Geology, College of William and Mary, Williamsburg, VA, 23187. We have mentored a number of students whose research projects involved the measurement of radon in the ground. At all study sites in Richmond and Williamsburg areas, the underlying stratigraphy was determined in detail by hand-augering the sediments or saprolite. Charcoal and alpha-track detectors were suspended in sealed auger holes for time periods of a week or less. Summary statistics for radon concentrations measured in the ground (picoCuries/liter) since 1989 are shown in the table below.

	Yorktown Fm (n = 92)	Bacons Castle Fm (n = 38)	Other Pleistocene Fm (n = 24)	Petersburg Granite (n = 55)
Mean	904	554	546	1215
SD	538	458	521	994
MAX	2302	1962	1974	4449
MIN	157	32	29	4

We believe that uranium-enriched fossilized bones at the base of the Yorktown Formation is the most probable source of elevated radon in the Williamsburg area. The characteristically large standard deviations suggest multiple measurements should be made over time and area of a site in question.

SEDIMENT CHARACTERISTICS IN A DEBRIS FAN EXPOSURE, MADISON COUNTY, VIRGINIA: S. E. Chase, A. S. Rutherford, and W. C. Sherwood, James Madison Univ., Harrisonburg, VA 22807. On June 27, 1995, approximately 27 inches of rain fell on portions of Madison County. High energy discharges from the Blue Ridge resulted in incisions of pre-existing alluvial fans to a depth of 3 meters or more. The present study concentrated on a fresh exposure along Kinsey Run, 1 mile west of Graves Mill. Near the west end of the exposure a total of 13 unlithified units ranging from coarse, bouldery, gravel to clayey silt were identified. The third oldest unit contains abundant organic matter which yielded a carbon date of 34,700 years B.P. Two coarse gravel beds in the sequence show significant rounding of charnockite clasts indicating a source to the west. Interbedded with these strata are units containing very angular clasts of a strongly foliated gneiss, rich in blue quartz. This material has its source to the south. Easterward, the stratified sediments are replaced by a jumble of fines, and angular gneissic clasts up to one meter across. The stratified sequence at the west end of the exposure is interpreted as interlayered alluvium (charnockite) from the west and gravity flow (solifluction?) of gneissic material from the south. The unstratified eastern part of the exposure is interpreted as resulting from one or more viscous debris flows.

THE USE OF "MICRODEM" IN TEACHING GEOLOGY. Stephen C. Clement, Dept. of Geology, College of William and Mary, Williamsburg, VA 23187-8795. The DOS-based computer program "MICRODEM" has been used effectively for several years in Physical and Historical Geology laboratories and in advanced courses at the College of William and Mary. The program displays digital elevation data, available from the U.S.G.S. and several commercial sources, and allows the student to construct topographic profiles and 3-D views. Students manipulate, learn and visualize the effects of vertical exaggeration, contour interval and scale. Slope, aspect and reflectance maps are used in geomorphic interpretation. Geophysical data such as bathymetry, gravity and magnetics can be displayed in adjacent panels and profiles constructed that relate the features. Student-generated xyz ASCII data can be entered and manipulated. The program is freeware and can be obtained by anonymous ftp from: <ftp.nadn.navy.mil/pub/ocean/microdem>. The author, Dr. Peter Guth, Associate Professor, can be contacted at: pguth@nadn.navy.mil

EFFECTS OF HUMAN IMPACT AND POLITICS ON WETLAND DELINEATION: CASE STUDY IN THE DISMAL SWAMP. Debra Duffy, James Lawrence and Robert Heffner*, Applied Marine Research Laboratory, Old Dominion University, Norfolk, Va. 23529. Historically policies of the US federal government encouraged the conversion of wetlands into filled or drained lands for agriculture or development. These policies and private efforts of similar nature resulted in the loss of millions of acres of wetlands throughout the US. As valuable attributes of such habitats became apparent, political support for protection of wetlands emerged in the 1970's primarily through Section 404 of the Clean Water Act (CWA). Private and political sectors for economic growth and the environmental community disagreed on the nature of federal regulation of wetlands. As a result, regulatory agencies began to develop wetland delineation manuals for the purpose of identifying jurisdictional wetlands. In 1989 the FWS, ACOE, NRCS and EPA adopted the Federal Interagency Manual, intended to ensure consistent regulation of wetlands, only to receive immediate complaints from regulated groups. A 1991 revision received criticism from the scientific and environmental community. In the interim, Congress directed the ACOE to revert to its own 1987 delineation manual to determine jurisdictional wetlands under the CWA. In 1993, at the request of Congress, the National Research Council (NRC) evaluated the scientific basis for characterization of wetlands in the federal regulatory system. The NRC study agreed with the regulatory basis of the 1989 Interagency Manual. Currently, Congress is ignoring the NRC study by considering legislation that would classify wetlands based on importance with only those of "critical importance" receiving protection now provided to all wetlands under the CWA. The Dismal Swamp of Va. is a classic example of wetlands that have been impacted by human and political efforts. Human impacts include drainage, dredging and filling of the Swamp. The newly proposed House bill, if passed, will leave much of the existing Dismal Swamp federally unprotected and subject to more degradation.

SWELLING PRESSURE INVESTIGATIONS OF ENDCAV AND FREDERICK SOILS. K. Hattori and W.C. Sherwood, Dept. Geology, James Madison Univ., Harrisonburg, VA 22807. Two residual soils (Endcav and Frederick Series), weathered from limestone in Rockingham County, VA, tested using a Potential Volume Charge (PVC) instrument. First, the Endcav soil, mapped as expansive, was tested for expansion at several different moisture contents. Expansion was found to increase progressively with moisture content up to 7.5% then to decrease from 7.5% to 15%. The pressure generated at 7.5% reached 3522 lbs/sq.ft. which is rated as critical. A second experiment involved 10 identical tests using air dried soils for each series to determine test variability. Pressures were found to range from 1601 lbs/ft² to 3122 lbs/ft², with a mean of 2424 lbs/ft² and standard deviation of 431 lbs/ft² for the Endcav, and 1665 lbs/ft² to 2722 lbs/ft² with a mean of 2071 lbs/ft² and a standard deviation of 317 lbs/ft² for the Frederick. Using a 5% value for tolerance and sampling risk it was determined that 51 tests for the Endcav and 38 tests for the Frederick would be required in order to secure a statistically valid mean. Finally, a t-test was conducted using the Endcav and Frederick test results. It was determined, that the means while appearing to be significantly different did not show a statistically valid difference at the 5% confidence level. High test variability, resulting from operator inexperience, was interpreted as the cause of the inconclusive results.

EFFECTS OF ORGANIC MATTER RICH TOPSOIL AND pH ON GERMINATION, GROWTH, AND METAL UPTAKE BY CORN GROWN IN FLUE DUST CONTAMINATED SOIL. Christopher A. Impellitteri, Prog. in Geol., Old Dominion Univ., Norfolk, VA 23529. The effect of pH on the mobility and availability of trace metals in soil is well documented. Trace metal mobility (and availability) generally increases with decreasing soil pH. This effect may cause mortality in plants grown in contaminated soil at low pH. Mortality may be decreased with the addition of an organic rich topsoil amendment. Preliminary experiments suggest that corn, germinated and grown in heavy metal contaminated soil with an organic rich topsoil amendment, has a higher biomass at harvest than corn grown in contaminated soil alone. For some metals, the higher biomass resulted in greater overall removal of the metal from the soil (e.g. Zn). For other metals (e.g. Pb), removal from the soil by plants was greater without the topsoil amendment. Further research is necessary in order to optimize conditions for phytoremediation of contaminated soils.

POSITION OF THE SALTWATER/FRESHWATER INTERFACE OF ACCOMACK COUNTY, VIRGINIA: PRELIMINARY RESULT OF A BASELINE SURVEY USING RESISTIVITY METHODS. Ali A. Nowroozi, Director, Program in Geological Sciences and Department of Mathematics and Statistics, and Stephen B. Horrocks*, Program in Geological Sciences, Old Dominion Univ., Norfolk, VA, 23529. Ground water is the only source of freshwater in the Eastern shore of Virginia. Large volume of groundwater withdrawals for various uses have caused water-level declines and concern about the possibility of future saltwater intrusion. Positions of the poor quality and salty waters are known at several locations from the well log data. Good quality freshwater has a resistivity of more than 70 Ohm m, while saline water has a resistivity of less than 4.5 Ohm m. Preliminary results from a baseline direct current resistivity survey consisting of 47 soundings, may provide distributions of saltwater, brackish water, poor quality and good quality water at resistivities of about 4.5, 15, 30, and 70 Ohm m respectively. We produced contour maps of depths variations to 70, 30, 15 and 4.5 Ohm m resistivity surfaces. Analysis of the contour maps reveals that good quality water is limited to a small area in the middle part of the county, at a depth of 30 to 40 m, mostly away from the coast. However poorer quality water may be found in a larger area up to a depth of about 150 meters. Depths to the saline water with 4.5 Ohm m resistivity are as shallow as 20 to 40 meters near several coastal areas and below 150 m in the interior region. We also produced contour maps of the resistivity variations at 5, 10, 20, 30, 50, 70, 100, and 150 m depth levels, and assumed the 30 Ohm m contour as the resistivity at the saltwater freshwater interface. At 5 and 10 m levels this contour is slightly inland close to coastal region of the Chesapeake Bay, in the east, and close to the Wallops and Assateague Islands, in the west. Between 20 to 70 m this contour penetrates from the Nandua Creek area in the southwest toward the township of Accomac in the northeast direction. Finally between 100 and 150 m, this contour moves further north toward Temperanceville. Additional surveys near Accomac, Temperanceville and Chicoteague are needed to provide the detailed geometry of the interface in these area.

INTERACTIVE GEOLOGIC HAZARDS INVENTORIES ON THE COMPUTER.

J.J. VanDerHurst¹ and C.F. Watts², ¹Dept. of Geological Sciences, Virginia Tech, Blacksburg, VA 24061, and ²Dept. of Geology, Radford University, Radford, VA 24142. The development of an interactive computer system for managing geologic hazards data bases is vital and overdue. As highway rock slopes continue to age and become more unstable and earthen dams are subjected to ever increasing flood events, a more proactive management system is required in order to provide timely information to planners and emergency personnel on demand. In recent years, fatalities have occurred associated with both highway rock slides and earthen dams failures in Southwestern Virginia. By producing a "geologic hazards" map for Southwestern Virginia, critical information concerning highway rock slopes and dams will be readily available. GIS-type applications are the ideal tool for this necessity.

We believe state agencies will find this a useful tool once a prototype is developed. Agencies that will benefit from such a computer model are the Virginia Department of Emergency Services, the Virginia Division of Mineral Resources, the Virginia Department of Transportation, and the Virginia Department of Conservation and Recreation. GIS-type applications are repeatedly proving to be on the cutting edge of geologic data management systems.

THE OLD LEAD MINES AREA IN WYTHE COUNTY, VIRGINIA: A TREASURE TROVE OF GEOHISTORICAL RESOURCES. Robert C. Whisonant, Dept. of Geology, Radford Univ., Radford, VA 24142. Few Virginians seem aware of the rich cultural heritage combining geology, geography, and human history afforded by the old lead mines area in southern Wythe County. The lead deposits are part of a Mississippi Valley-type, carbonate-hosted metallic sulfide belt in the Shady Dolomite in the Great Valley just west of the Blue Ridge. Pre-Civil War historic notes of interest include: opening of the lead mines in 1756 by Col. John Chiswell; writing of the Fincastle Resolutions in 1775; birth of Stephen F. Austin in 1793; and construction of the Shot Tower from 1807 to 1812. During the Civil War, 1861-1865, the Wythe County lead mines produced virtually all of the Confederacy's domestic lead supply. Despite Union threats in July 1863 and May 1864, the lead mines remained untouched until December 1864, when Gen. George Stoneman's troops destroyed not only the lead works, but salt and iron operations in the region as well. This same raid also devastated the Virginia and Tennessee railroad, over which the lead and other valuable materials moved. After the Civil War, the Austinville-Ivanhoe mines produced primarily zinc until final closure in 1981.

REVISING THE GEOLOGY CURRICULUM: A NEW COURSE IN EROSION AND SEDIMENT CONTROL/STORMWATER MANAGEMENT. Robert C. Whisonant, Dept. of Geology, Radford Univ., Radford, VA 24142. The geology profession is changing rapidly as environment-related jobs replace mineral extractive ones. College and university geology curricula must change also or face extinction. Radford University's geology program has long emphasized engineering geology, which we broadly define to include hydrogeology and environmental geology as well as other topics typically found in applied geology. I developed a new course in erosion and sediment control/stormwater management to enhance our curriculum. Inspiration for the course came through my involvement as a technical expert in a sediment injury case when I realized how poorly trained most geologists are in this new field. The course was designed to provide senior-level geology majors (or those in related fields) with training normally found only in courses in civil engineering, agronomy, or landscape architecture. The course involved a mix of lectures, classroom discussions of reading assignments, problem solving, field trips, computer software demonstrations, and interaction with guest professionals. A major written research paper and oral presentation of that material were required as "capstone" activities. Feedback from the students was very positive. They seemed genuinely excited about their research projects and particularly about participating in one of the few erosion and sediment control/stormwater management courses taught in a geology department in the nation.

GEOMORPHOLOGY AND PALEOBOTANY OF A MAMMOTH-BEARING SITE, RUSSELL COUNTY, VIRGINIA. Thomas A. Wynn and G. Richard Whittecar, Prog. Geological Sciences, Old Dominion Univ., Norfolk, Va. 23529. The Ratcliff Pleistocene Site lies in a first-order valley on the north-western slope of Clinch Mountain that drains into Moccasin Creek. Preserved within the deposit are mastodon bones, logs, pine cones, and other plant macrofossils. Radiocarbon analyses indicate the age of the organic-rich sediments range from 29,100 BP to > 44,000 BP, a time period with no fossil remains reported in this region of the Appalachians. The stream which carved the valley was diverted midway down the mountain by a large landslide, presumably before the Late Pleistocene. Debris flows and other alluvial deposits from adjacent streams raised the valley bottom of Moccasin Creek and dammed the abandoned lower valley. As much as 5.2 m of organic-rich sediments accumulated in the hollow prior to 29,000 BP. Uniformly dark grey, this sediment consists of alternating layers of compact silty clay and poorly sorted stoney silty clay. Sedimentation rates increase upward through the section with radiocarbon dates from 0.009 cm/yr to 0.02 cm/yr to 0.05 cm/yr, probably due to increased influence of debris flow deposition. After 29,000 BP, debris fan deposits from adjacent valleys buried the site in nearly 5 m of pebbly colluvium.

Oldest sediments preserve plant remains of a boreal forest that became increasingly wet by ~35,000 yBP. By 29,000 yBP the site became boggy with grass and some open water areas.

ELEVATION AS A CONTROL ON THE FORMATION OF BOULDER STREAMS IN THE BLUE RIDGE OF VIRGINIA. Marc D. Zamkotowicz and G. Richard Whittecar, Prog. Geological Sciences, Old Dominion Univ., Norfolk, Va. 23529. Bouldery colluvium carpets the bottoms of high-altitude valleys in the Blue Ridge Mountains from Pennsylvania to North Carolina. Some of these deposits contain tightly-wedged clasts with a sandy matrix that fills only the lower portions, often exhibit a convex-upward cross-valley profile, and are continuous and relatively uniform masses that grade up-valley into talus. Many workers now recognize these features as boulder streams (block streams) formed by periglacial processes. If this periglacial hypothesis is correct, boulder streams with these characteristics should be ubiquitous in small valleys above a critical elevation that rises to the south, a gradient controlled by Pleistocene climates. Mapping in four study areas across Virginia with relatively massive, crystalline rock types and with a variety of valley head elevations suggests that the critical elevation for the formation of boulder streams increases to the south (approximate latitude::estimated critical elevation - 39.2°::500 ft; 37.8°::1600 ft; 37.5°::2500 ft; 36.7°::4300 ft). Initial analyses of clast orientation data indicate that high-angle tabular clasts, usually oriented subparallel to the valley axis, are common in Virginia boulder streams. Such "vertical" clasts are a very common feature in modern periglacial environments due to frost action. Thus all results of this study support the periglacial hypothesis for boulder stream formation.

Materials Science

CONSTRAINED-FILM SINTERING OF GLASS. Jaechol Bang and Guo-Quan Lu*, Dept. of Materials Science and Engineering, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0237. The densification behavior and microstructural evolution of constrained film were studied in a borosilicate glass (BSG)+silica system because of their applications in microelectronic packaging technologies. Powder packings with varying ratios of BSG to silica were prepared by casting powder + binder slurries into freestanding films and films constrained on a rigid substrate. Sintering experiments were carried out in a hot stage at temperatures between 715°C and 775°C. Optical techniques were developed for measuring the densification rates of the free and constrained films, and in-plane stresses generated in the constrained-sintering films. The densification rates measured in the constrained films were slower than those in the free films. However, the substrate constraint had no effect on the activation energy of densification which was found equal to 385 ± 10 kJ/mol, the same for both free and constrained films. We also measured in-plane stresses developed in a BSG film during its constrained sintering on a rigid substrate. The measured stresses were tensile and rose rapidly from zero to a maximum level of 20 kPa during the initial stage of sintering and gradually decreased to zero at the final stage; these stresses are considerably smaller than those calculated from available microstructural models. We believe that the stresses could have prevented a few large pores from shrinking during the initial stage of sintering, which then leads to an overall lower density and larger pores in the constrained film.

MEASUREMENT OF IN-PLANE STRESSES DURING THE SINTERING OF CONSTRAINED ZINC OXIDE FILMS. Jesus Noel Calata & Guo-Quan Lu*, Dept. of Materials Science and Engineering, Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061-0237. Many microelectronics products such as packages and substrates undergo constrained-film sintering during fabrication. Sintering of constrained films not only leads to reduced densification but also to a buildup of in-plane stresses in the film. These stresses can be particularly large in polycrystalline materials compared to amorphous materials due to the absence of a fast relaxation mechanism. They can lead to defects in sintered products such as camber, distortion and cracking. In this study, the in-plane stresses during the isothermal sintering of zinc oxide powder films constrained on silicon were experimentally determined using an optical setup. In this technique, the curvature of the constrained film was monitored using a position sensitive photodetector. The results indicated stress levels an order of magnitude higher than those observed in constrained glass films. The time-dependent stress profiles show a stress buildup during the early stage of sintering corresponding to rapid densification. The stress then gradually decreases as the densification rate decreases. There was a significant level of stress that remained after sintering. This behavior was observed at all the sintering temperatures used. For the same relative density, the stress also decreased with increasing sintering temperature which suggests a temperature dependence of the in-plane stresses.

Structure/Property relationships for a single tow ceramic matrix composite, P.E. Cantonwine and H.N.G. Wadley*, University of Virginia, Charlottesville, VA. As an alternative to SiC monofilaments, both 3M and UVa have investigated reinforcing metal matrices with a lower cost Al_2O_3 tow fiber (Nextel 610). To avoid the many difficulties of trying to uniformly distribute 10 μm fibers in a metal matrix, a novel processing technique was developed. This technique involves "gluing" the 420 filaments of the Al_2O_3 tow together with a porous alumina binder. The result is a single tow ceramic matrix composite (CMC) or $\text{Al}_2\text{O}_3/\text{Al}_2\text{O}_3$ hybrid fiber which may be coated with matrix material via physical vapor deposition, tape casting or plasma spray deposition. Our current objective is to fully understand the process/structure/property relationships of the $\text{Al}_2\text{O}_3/\text{Al}_2\text{O}_3$ hybrid fiber. The process involves infiltrating a single fiber tow with an alumina tape casting slurry followed by a burn-off and sintering stage. The sintering was done at 1100 °C for 10 hr. which created a partially consolidated (i.e. porous) alumina binder. The volume fraction of filaments in the hybrid fiber were between 50 and 65%. Tensile tests were performed on both as-received fiber tow and $\text{Al}_2\text{O}_3/\text{Al}_2\text{O}_3$ hybrid fiber. Ideal bundle theory models over-estimated the tensile results and it is hypothesized that non-ideality in the tow (e.g. misalignment) caused the lower than predicted strengths. Initial observations indicated the load transfer was controlled by the shear strength of the porous binder.

CONTROLLING THE FORMATION OF IRON-ZINC ALLOYS IN COMMERCIAL GALVANNEALED STEEL. *Desmond C. Cook¹ and Richard G. Grant², ¹Department of Physics, Old Dominion University, Norfolk, VA 23529, and ²Department of Physics, Roanoke College, Salem, VA 24153. Analyses of thirty commercially produced galvaneal, (Zn-Fe alloy), coatings on steel have been completed using Mössbauer spectroscopy and Scanning Electron Microscopy. Scattering Mössbauer spectra were recorded in-situ using conversion electrons, (CEMS), to identify the surface phases and re-emitted γ -rays, (GMS) to identify all phases present in the coatings. The measured phase fractions in each coating were compared with SEM metallographic cross-section analysis, galvaneal production parameters and mechanical properties of the coatings. It has been concluded that the zinc-rich Zeta phase forms only at low anneal temperatures less than 500°C. At higher temperatures up to 550°C, the amount of Delta phase which forms, as well as its iron concentration, increases. For anneal temperatures between 550°C and 600°C, the fractions of the Gamma-1 and Gamma phases increases at the expense of the Delta phase. #Supported in part by the International Lead Zinc Research Organization, Inc., grant ZM-403 and Virginia's Center for Innovative Technology, grant MAT MFG-95-0-130.

AN IMPROVED N-TYPE MATERIAL FOR THERMOELECTRIC COOLING DEVICES IN THE $(\text{Bi}_2\text{Te}_3)(\text{Sb}_2\text{Te}_3)(\text{Sb}_2\text{Se}_3)$ ALLOY SYSTEM. M. H. Ettenberg, W. A. Jesser and F. D. Rosi*, Department of Materials Science and Engineering, University of Virginia, Charlottesville, Virginia, 22903. The pseudoternary alloy of $(\text{Bi}_2\text{Te}_3)(\text{Sb}_2\text{Te}_3)(\text{Sb}_2\text{Se}_3)$ has been explored for over twenty-five years with little progress in the figure of merit. The p-type alloy was established as $(\text{Bi}_2\text{Te}_3)_{25}(\text{Sb}_2\text{Te}_3)_{72}(\text{Sb}_2\text{Se}_3)_3$ with Te as a dopant and this produced material with a figure of merit of $3.4 \times 10^{-3}/\text{K}$. The n-type alloy was $(\text{Bi}_2\text{Te}_3)_{90}(\text{Sb}_2\text{Te}_3)_5(\text{Sb}_2\text{Se}_3)_5$ doped with SbI_3 with a figure of merit of $3.2 \times 10^{-3}/\text{K}$. Increasing the composition of Sb_2Te_3 in the alloy theoretically increases the figure of merit by lowering the lattice contribution to the thermal conductivity, at the same time making the alloy more p-type in nature. Using multiple dopants, Te and SbI_3 , has permitted the creation of an n-type alloy with a single dopant because the material is inherently a strong p-type material and the solubility of the dopants would be exceeded before the optimum thermoelectric properties were reached. Using multiple dopants in this new alloy produces n-type material with a figure of merit of $3.4 \times 10^{-3}/\text{K}$. The present p-type material also benefits from the use of multiple dopants, Te and SbI_3 . Higher figure-of merit material has been achieved without precipitating pure Te commonly found as a deleterious second phase in the p-type alloy. Using a combination of the two dopants, figures of merit as high as $3.7 \times 10^{-3}/\text{K}$ have been achieved in the p-type alloy.

FILM SYNTHESIS VIA DIRECTED VAPOR DEPOSITION. James F. Groves and Haydn N. G. Wadley*. Materials Science and Engineering Dept. Univ. of Virginia, Charlottesville, VA 22903. Economic considerations are motivating the development of new, less expensive vapor deposition processing technologies capable of beneficially manipulating process parameters to create high quality thick and thin film microstructures. A directed vapor deposition (DVD) technique has been invented and is now being explored as a potential thick or thin film synthesis tool. The technique exploits supersonic inert carrier gas jets in combination with electron beam evaporation under low vacuum conditions (0.01-10 Torr) to atomically spray deposit a potentially wide variety of monolithic and composite materials. The most important processing parameters that control deposition (the carrier gas velocity and the deposition chamber pressure) have been identified, and their effect upon deposition efficiency for flat and fiber substrates has begun to be systematically explored as the first step in a study of process-property relationships in the DVD system. A computational fluid dynamics model is being used in combination with a kinetic theory of gases based vapor atom tracking model to help identify the role of carrier gas dynamics in controlling adatom deposition efficiency, energy, distribution, and angle and to assess the ability of the technique to manipulate other important process parameters.

EVALUATION OF INTERFACIAL ADHESION OF FIBER REINFORCED POLYMER COMPOSITES BY VIBRATION DAMPING. Weiqun Gu¹, Guo-Quan Lu^{1*}, H. Felix Wu^{2*}, and Stephan L. Kampe^{1*}, ¹Department of Materials Science and Engineering, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0237, and ²Composites Innovation, Owens-Corning Science and Technology Center, Granville, OH 43023. The mechanical behavior of fiber reinforced composites is largely determined by adhesion at fiber-matrix interfaces. A fundamental understanding of the interfacial region and a quantitative characterization of the level of interface adhesion can contribute to an evaluation of the mechanical behavior and capabilities of composite materials. Among numerous techniques for interface characterization, vibration damping method has attracted ever more attention, because it provides a sensitive and nondestructive detection of the interfacial region. The damping at the interfaces will therefore enable us to quantify the interface adhesion. The technique will facilitate the materials industry to rapidly determine the mechanical properties of composites. In present research, a new optical system for measuring vibration damping was introduced, and a model for evaluating the adhesion between fiber and matrix from damping parameters was developed. A quantitative relationship between the dynamic (vibration damping) and static (interfacial shear strength) adhesion measurements was established. The experiment data from glass fiber reinforced epoxy resin composites with different interfacial treatment showed a good agreement with the developed model.

TENSILE BEHAVIOR OF CROSS-PLY BLACKGLAS™ CMC'S. Rebecca K. Herrmann*, Stephen L. Kampe* and William A Curtin*, Materials Science and Engineering Department, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. The tensile behavior of a symmetric cross-ply Blackglas™ ceramic matrix composite (CMC) reinforced with Nicalon fibers was observed. Initial observations of the composites showed significant porosity and some cracking in the Blackglas™ samples. Fracture mirror measurements were observed on the fracture surface of the fibers to determine the in-situ strength of the Nicalon fibers. Resulting characteristic strength and Weibull modulus values combined with measured fiber pullout lengths were then used to determine material parameters such as the ultimate tensile strength, strain to failure, work of pullout, sliding distance at the characteristic strength, and interfacial shear stress. Comparisons of measured and calculated ultimate tensile strengths and strains to failure showed good agreement. This research was sponsored by the Naval Surface Warfare Center (NSWC) in Dahlgren VA.

IDENTIFICATION OF THE CORROSION PRODUCTS ON THREE WEATHERING STEEL SAMPLES USING IN-SITU MÖSSBAUER ANALYSIS. Sei Jin Oh and D.C. COOK, Department of Physics, Old Dominion University, Norfolk, VA 23529.

The atmospheric corrosion products formed on the three samples of weathering steel, have been identified using Mössbauer spectroscopy and x-ray diffraction. The three samples were exposed to the atmosphere for times between 11-29 years in two different industrial environments (one in Bethlehem, Pennsylvania, U.S.A. and the another in Amagasaki, Japan). The scattering Mössbauer spectroscopy and x-ray diffraction were used to analyze the iron oxide phases while they remained intact of the steel substrate. The coatings on the three samples were found to be very similar, with each containing a large fraction (>80%), of γ -FeOOH (lepidocrocite), and a smaller fraction (~15%), of α -FeOOH (goethite). Two samples contained a very small amount (3%), of γ -Fe₂O₃ (maghemite). No β -FeOOH (akaganeite) was not found in the corrosion products. The result suggest that, due to the similar fractions of the iron oxide phases in each corrosion coating, the three samples had reached phase stability and that weathering steel probably does not undergo any appreciable weathering after 11 years with exposure .

THE CREEP BEHAVIOR OF TI-6242S/SCS-6 CONTINUOUS FIBER COMPOSITES AT 600°C. Dana T. Russell and H.N.G. Wadley*, Dept. of Materials Science and Engineering, Univ. of Va, Charlottesville, VA 22903. The longitudinal creep behavior of a Ti-6Al-2Sn-4Zr-2Mo-0.1Si (wt%) matrix unidirectionally reinforced with about 40 vol% silicon carbide (SCS-6) fibers fabricated by plasma-spray deposition has been experimentally investigated and compared to a recent creep rupture model. The Ti-6242S/SCS-6 creep response has been measured at 600°C in argon at stresses ranging from 759 to 1112 MPa. The composite rupture life followed the trend of the creep model (exhibiting a decreasing life with increasing applied stress) but exhibited a 275 MPa strength degradation relative to the model prediction. Modifications of the creep model to account for the effects of 1) thermal residual axial stresses in the matrix and the fibers, 2) matrix transient creep and 3) pre-existing fiber fractures and fiber bending stresses (observed metallographically) were investigated to explain this strength loss. Only the latter contribution had a significant effect on the creep rupture life and the best correlation with the data was obtained assuming 50 breaks per meter of fiber which was similar to the effective number of fractures observed in the as-consolidated composites. The creep response of the Ti-6242S/SCS-6 composites was therefore found to be dependent on processing damage.

PROCESSING OF ALUMINUM ALLOYS CONTAINING DISPLACEMENT REACTION PRODUCTS. M. T. Stawovy, A. O. Aning and S. L. Kampe, Materials Science and Engineering Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, 24061. The use of aluminum alloys at high temperatures requires the use of dispersion strengthening as the primary strengthening mechanism. Historically, mechanical alloying (MA), followed by powder metallurgy consolidation techniques, has been used to produce dispersion strengthened aluminum alloys. In that case, surface oxides or other oxides added to the powder mixture are primarily responsible for strengthening. In this study, composite powders of aluminum - (1-20 mol%) Fe_2O_3 were first produced using MA. A "thermite-type" displacement reaction, which leads to the formation of the dispersoids of Al_2O_3 , $\text{Al}_{13}\text{Fe}_4$ and AlFe , was initiated in two different ways. The reaction was triggered in the mill by prolonged milling, or the premilled powders were annealed to produce the dispersoids. Dispersoid size formed in this manner depended on the MA milling conditions. Longer milling times resulted in a reduction of the reaction product size.

ATOMISTIC SIMULATION OF DEFECTS IN INTERMETALLICS. Christophe Vailhé and Diana Farkas, Dept. of Materials Science and Engineering, Virginia Tech, Blacksburg, VA 24061-0237. Although aluminides with the B2 crystal structure have good properties for high temperature applications, the strong ordered bonds that make them durable at high temperature also make them too brittle at room temperature for industrial fabrication. In order to better understand this lack of ductility, molecular statics simulations of planar fault defects and dislocation core structures were conducted in a series of B2 aluminides with increasing ordering energy (FeAl, NiAl, CoAl). As the cohesive energy increases from FeAl to CoAl, antiphase boundary and unstable stacking fault energies increase resulting in more constricted dislocation core spreadings. This constriction of the cores decreases the mobility of dislocation with planar core structures and increases the mobility of dislocations with non-planar cores. The simulation results in NiAl were compared with in-situ straining observations of dislocation motions. Both in-situ observations and atomistic simulations agreed on the zig-zag shape of the $\langle 100 \rangle$ dislocation with an average screw orientation. In this configuration, the mobility of the dislocation is severely reduced.

Medical Science

DIFFERENTIAL EXPRESSION OF CB1 CANNABINOID RECEPTOR mRNA IN THP-1 MACROPHAGE-LIKE CELLS. Douglas L. Anders*, Denise A. Dove Pettit*, Guy A. Cabral. Dept. of Microbiology and Immunology, Va. Commonwealth Univ., Richmond, Va. 23298. Cannabinoids, such as delta-9-tetrahydrocannabinol (THC), exhibit a multiplicity of physiological effects such as anamnesia, analgesia, and suppression of immune cell function. The recent identification of both neural (CB1) and peripheral (CB2) cannabinoid receptor subtypes suggests a mechanism by which cannabinoids mediate these diverse effects. The objective of this study was to apply a novel and highly sensitive mutagenic reverse transcription-polymerase chain reaction (MRT-PCR) strategy for the definition of differential cannabinoid receptor mRNA expression in immune cells. MRT-PCR allows for discrimination of amplification of genomic DNA versus that of cDNA and for standardization for relative quantities of mRNA using genomic DNA as an internal standard. Using this technique, mRNA for CB1 was identified in human pre-monocytic THP-1 cells. Total RNA collected from interferon-gamma ($\text{IFN-}\gamma$)-primed THP-1 cells, LPS-activated THP-1 cells, or THP-1 cells simultaneously exposed to $\text{IFN-}\gamma$ and LPS, was subjected to MRT-PCR and results were compared with those obtained for untreated THP-1 cells. Analysis of amplification products indicated that $\text{IFN-}\gamma$ and LPS treatment alone reduced CB1 mRNA expression in THP-1 cells. Furthermore, the reduction of CB1 mRNA was maximal (>90%) when THP-1 cells were treated with $\text{IFN-}\gamma$ plus LPS. These results suggest that CB1 receptor mRNA expression in THP-1 macrophage-like cells is modulated during macrophage progression to full activation. Supported by NIH awards DA05832, DA09158, and T32 DA07027.

CHARACTERISTICS OF NICOTINE'S DISCRIMINATIVE STIMULUS IN C57/BLACK 6 MICE. David Arthur, Stephen Varvel, Lori Karan, J. Randy James, and John A. Rosecrans, Dept. of Pharmac., Va. Commonwealth Univ., Richmond, Va. 23298-0613. Previous research conducted in this and other laboratories has examined the role of genetic factors in determining sensitivity to nicotine in a variety of behavioral and physiological measures the rat. More recent research further indicates that genetic factors can also influence the level of sensitivity to nicotine when serving as a discriminative stimulus (DS) in different rat strains. However, there has been little work examining the influence of genotype on the DS properties of nicotine in mice, a species that has played a major role to understanding the relationship between genetics and nicotine's pharmacological effects. To further our understanding of the role genetics and the ability of nicotine to exert DS control of behavior in the mouse, a group of C57BL/6 mice was trained to discriminate 0.4mg/kg (-)nicotine from saline using a two-lever operant procedure. Nicotine's DS in C57BL/6 mice appears to be similar to that generated in the rat. Results from behavioral tests with other drugs indicated that (+)amphetamine exhibited a partial generalization while (+)nicotine fully generalized with nicotine. Tests of antagonism with mecamylamine and scopolamine further showed the cholinergic specificity of the nicotine DS in the mouse; mecamylamine but not scopolamine did completely antagonize the nicotine DS. This work lays the groundwork for future comparisons of different mouse strains' sensitivities to nicotine's DS as well as using this behavioral model to search for new nicotinic-acetylcholinergic receptor (nAChR) agonists and antagonists. (NIDA grant DA-00183)

CYCLIC NUCLEOTIDE-DEPENDENT KINASES HAVE DIFFERENT ROLES IN THE BRAIN AND SPINAL CORD OF MORPHINE-TOLERANT MICE. Marissa A. Bernstein and Sandra P. Welch, Dept. of Pharmacology and Toxicology, Virginia Commonwealth Univ., Richmond, VA 23298. Many studies suggest that phosphorylation plays a role in the neuroplasticity associated with opioid tolerance. We examined the effect of inhibiting cyclic nucleotide-dependent protein kinase activity in the brain or spinal cord of morphine-tolerant mice. KT5720, a cAMP-dependent protein kinase (PKA) inhibitor, or KT5823, a cGMP-dependent protein kinase (PKG) inhibitor, was centrally administered in morphine-tolerant and placebo-treated mice prior to a systemically administered challenge dose of morphine. KT5720 administered intracerebroventricularly (i.c.v.) completely reversed morphine tolerance in the tail-flick assay; KT5823 had no effect on morphine via this route. When either of these compounds was administered intrathecally (i.t.), the activity of morphine was greatly diminished in the tolerant animals, with no effect on morphine antinociception in the placebo group. Upregulation of PKA activity in the brain may be critical to the expression of tolerance to the antinociceptive effects of morphine. In the spinal cord, however, the activity of cyclic nucleotide-dependent protein kinases, and possibly their substrate proteins, may be affected by chronic morphine exposure such that inhibition of these kinases produces hyperalgesia. (Supported by NIDA grants DA07027, DA00186, DA06031.)

ETHANOL-LIKE DISCRIMINATIVE STIMULUS PROPERTIES OF SEVERAL ALKYL BENZENE SOLVENTS. Scott E. Bowen, M. Tokarz and R.L. Balster. Dept. of Pharmacology & Toxicology, Med. Col. of Va., Richmond, VA 23298-0613. It has been hypothesized that abused solvents may have behavioral and pharmacological effects that are similar to those of abused depressant drugs such as barbiturates and ethanol. Drug discrimination procedures have been used previously in our laboratories to assess the perception of several of these inhalant effects in laboratory animals. In an attempt to further clarify these discrimination effects, the present experiment was designed to compare the discriminative stimulus effects of ethanol (ETOH) and several volatile alkylbenzenes. Male albino mice were trained to discriminate between i.p. injections of ETOH (1.25 g/kg) and saline in a two-lever operant task in which responding was under the control of a fixed-ratio 20 (FR20) schedule of food presentation. Stimulus generalization was examined after 20-min inhalation exposures to toluene (1000-6000 ppm), ethylbenzene (500-4000 ppm) and propylbenzene (500-4000 ppm). Concentration-related increases in ETOH-lever responding were observed for all three volatile compounds with toluene displaying the highest levels of ethanol-lever responding. Supported by NIDA grant DA-03112 and DA-05670.

A NOVEL CLASS OF COVALENT CROSS-LINKERS OF HEMOGLOBIN SUBUNITS AS ENHANCERS OF OXYGEN RELEASE. Telih Boyiri and Donald J. Abraham, Dept. of Medicinal Chemistry, Va. Commonwealth Univ., Richmond, Va. 23298-0540. The N-terminal amino region of hemoglobin (Hb) α subunits was modeled, using GRID, with the aim of finding additional binding interactions after a Schiff base has formed between the protein and an aldehyde molecule. The GRID carboxylate and hydroxyl probes identified two sites for electrostatic and hydrogen bonding interactions. Monoaldehyde acids were modeled to form a Schiff base with the Val 1 α and a salt bridge with Arg 141 α of the opposite subunit. It was envisioned that these molecules would produce high affinity hemoglobins. X-ray analyses indicated that the molecules did bind as modeled *de novo* in symmetry related pairs. However, all Hb-effector solutions exhibited right shift oxygen dissociation curves opposite to that expected. It was hypothesized that the observed right shift was due to the formation of a salt bridge between the carboxylate ion of the monoaldehyde and the guanidinium ion of Arg 141 α of the opposite subunit. The salt bridge ties together the α subunits across the molecular symmetry axis and as a result, shifts the allosteric equilibrium in favor of the T-state. To investigate this hypothesis a series of bisaldehydes with varying chain lengths were designed, synthesized, and evaluated as allosteric effectors of Hb. X-ray analyses of all the bisaldehyde-Hb complexes revealed exclusive cross-links between Val 1 α and Lys 99 α of the opposite chain. Even though the two Val 1 α nitrogens are ideally spaced to form cross-links, the long flexible bisaldehydes did not bind to this locale; they prefer to bind along cavity walls rather than span large open spaces with few chances for interaction. The tighter the cross-link, the more stabilized the T-state and the stronger the allosteric effect that is produced. The cross-linked hemoglobins retain cooperativity, exhibit low oxygen affinity, and may be potential candidates for use as cell-free Hb based blood substitutes.

PARTIAL PURIFICATION OF GLYCOPROTEINS FROM NAEGLERIA FOWLERI. Timothy M. Breeden, Dept. of Chem., Fl. State Univ., Tallahassee, Fl. 32306, & F. M. Cabral, Dept. of Micro. and Immunol., Va. Commonwealth Univ., Richmond, Va. 23298. The genus Naegleria is comprised of a distinctive group of free-living amoebae found in soil and freshwater lakes and ponds. Both pathogenic and nonpathogenic species have been identified but only one species, Naegleria fowleri, has been isolated from infected human patients. N. fowleri is the causative agent of Primary Amebic Meningoencephalitis (PAME); a rapidly fatal disease of the central nervous system (CNS). Membrane proteins (specifically surface glycoproteins) are under investigation because they may play a role in pathogenicity by mediating recognition, attachment and invasion. Surface proteins of highly pathogenic N. fowleri may function to resist complement mediated lysis. The present study was undertaken to identify possible virulence factors associated with the highly pathogenic strain of N. fowleri, LEEmp. Membrane proteins from LEEmp were partially purified using preparative SDS-PAGE gel electrophoresis. The fractions of interest (42-46 kDa) were pooled and concentrated. Lectin analysis and 2D SDS-PAGE gel electrophoresis were used to characterize these protein(s). (Supported in part by grant J-294 from the Thomas F. and Kate Miller Jeffress Memorial Trust, Richmond, Va.)

SCHISTOSOMA MANSONI: SEQUENCE OF A PUTATIVE FEMALE-SPECIFIC cDNA. Catherine Cardullo, Suzanne Wirth* & Maryanne Simurda. Biol. Dept., Washington & Lee Univ., Lexington, VA 24450. A clone isolated from the female-specific cDNA derived by the subtractive hybridization with male mRNA of the adult worm, *S. mansoni*, has been analyzed. By restriction enzyme mapping, this cDNA, designated 4.28, is 660 base pairs. From the partial cDNA sequence data obtained to date and potential open reading frame this cDNA encodes a 128 amino acid protein.

ISOLATION OF PDGF- α mRNA IN INTIMAL CELLS FOLLOWING ANGIOPLASTY BY IN SITU POLYMERASE CHAIN REACTION. Aubri L. Charboneau, Gary L. Brown & Kathryn E. Loesser, Dept. of Biol., Mary Washington Col., Fredericksburg, VA. 22401. The exact mechanism for development of atherosclerosis has not been determined, although platelet-derived growth factor (PDGF- α), is thought to play an important role in this process by acting as a chemotactic factor attracting smooth muscle cells to the intima and stimulating them to divide. Recent discoveries have shown that dehydroepiandrosterone (DHEA) attenuates the progression of the proliferative responses thought to be involved in the restenosis and atherosclerosis process. The specific aim of this project was to show that DHEA attenuates the proliferative events in restenosis by inhibiting the expression of PDGF- α , and therefore inhibiting the atherogenic actions of PDGF- α . This theory was tested by localizing the mRNA for PDGF- α in the cell following treatment with DHEA. I proposed that there would be a reduced expression of mRNA for PDGF- α in animals treated with DHEA. The results of this experiment show that 100% of the sections in the high DHEA treated group had no PDGF- α expression and 100% of the control (no DHEA) treated group showed significant presence of PDGF- α mRNA in the intima. Therefore DHEA could prove very beneficial in reducing the incidence of restenosis after angioplasty in the future.

EVALUATION OF ASIAN PLANT EXTRACT MATERIALS AS POTENTIAL THERAPEUTIC AGENTS AGAINST *ACANTHAMOEBA*. Dan-My T. Chu, D. Toney*, F. Marciano-Cabral, Dept. Micro. & Immunol., Va. Commonwealth Univ., Richmond, Va. 23298, & H. Miles*, Dept. of Chem., Univ. of Central Fl., Orlando, Fl. 32816. Members of the genus *Acanthamoeba* are pathogens which cause amebic keratitis and Granulomatous Amebic Encephalitis (GAE). GAE generally occurs in immunosuppressed and chronically ill individuals. Amebic keratitis can occur in healthy individuals who injure the cornea and are exposed to *Acanthamoeba*. *Acanthamoeba* infections are difficult to treat because the amebae encyst in tissues. We have evaluated empirically, 100 extracts derived from flowers, stems, leaves, roots, or whole plants obtained from Southeast Asia for amebicidal activity against 3 species of *Acanthamoeba*. Plants were extracted with methanol to obtain a polar fraction, designated fraction B, or with methylene chloride to obtain a nonpolar fraction, designated fraction A. Extracts were incubated with ^3H -uridine labeled amebae and the release of radiolabel was used as an index of lysis. Of the 100 plants tested, three contained natural constituents which exhibited amebicidal activity or growth inhibitory activity in vitro. Plant extracts, 29B and 74A, lysed *Acanthamoeba* but 29A and 74B were ineffective. Extract 75A did not lyse the amebae but exhibited growth inhibitory activity. Further purification of plant extracts are necessary to identify the active amebicidal components.

CANNABINOID ANTAGONIST PRECIPITATES WITHDRAWAL IN MICE AFTER CHRONIC CANNABINOID EXPOSURE. S. Cook and B. Martin, Dept. of Pharmacology and Toxicology, Med. Col. of Va.-Va Commonwealth Univ., Richmond, Va 23298. The existence of physical withdrawal development to cannabinoids has been difficult to establish especially because cannabinoids have such a long half-life. The recently characterized cannabinoid antagonist, SR141716A (SR), has been used to precipitate withdrawal in rats chronically treated with Δ^9 -THC. Precipitated withdrawal behaviors include tremors, facial rubbing, and hyperactivity. Based on our hypothesis that SR will precipitate withdrawal in mice chronically treated with Δ^9 -THC, the objective of this study was to develop a mouse model for physical dependence. A dose-response curve for SR was conducted first. Mice were treated with Δ^9 -THC (10 mg/kg) or vehicle s.c. for 6.5 d. On day 7, various doses of SR or vehicle were administered i.p. 4 hrs after the last Δ^9 -THC injection. Immediately following the SR delivery, the mice were observed for 30 mins for unique and typical withdrawal behaviors. Using the same protocol as above, mice were treated with different doses of Δ^9 -THC or vehicle chronically and then challenged with an acute dose of SR (10 mg/kg or 30 mg/kg) or vehicle. Numerous withdrawal behaviors were observed in both experiments but paw tremors were the most pronounced and dose-dependent with respect to increasing doses of antagonist and Δ^9 -THC. In summary, SR precipitated withdrawal in mice chronically treated with Δ^9 -THC and this observation is consistent with SR-induced precipitated withdrawal in rats. Supported by NIDA grants DA07027 and DA03672.

TRAUMATIC BRAIN INJURY-INDUCED LIMBIC EPILEPTOGENESIS: ANATOMICAL AND ELECTROPHYSIOLOGICAL EVIDENCE. Douglas Coulter^{1,2}, Azhar Rafiq¹, Melissa Shumate², Q-Z. Gong³, Robert J. DeLorenzo^{1*}, Bruce Lyeth^{3*}, Dept. of Neuro.¹, Phys.², and Neurosurg.³, VA. Commonwealth Univ., Richmond, Va. 23298. A major cause of remote symptomatic epilepsy in young adults is traumatic brain injury (TBI). Mechanisms underlying this increased susceptibility are unknown. To model a closed head TBI, adult rats were subjected to a moderate (2.0 atm) lateral fluid percussion injury and studied 7-180 days post-injury. In physiological studies, hippocampal entorhinal cortical (HEC) slices were prepared from TBI and sham-operated control animals and results compared to an animal model of temporal lobe epilepsy, pilocarpine-treated rats (PILO). Ipsilateral HEC slices prepared from TBI animals 1 week post-injury displayed stimulus-evoked afterdischarges which, after ≥ 5 trains, developed into continuous epileptiform activity lasting > 30 min in $> 50\%$ slices. HEC slices prepared 1, 2, and 6 months post-TBI showed greater excitability than control, but much less than the 1 week post-TBI slices. Activity in contralateral TBI slices was similar to controls. PILO slices were similarly hyperexcitable as seen in 1 week post-TBI slices. In anatomical studies, brains were prepared for cresyl violet or Timm's stain. Both two month post-TBI and PILO animals showed similar 20-30% cell loss in hippocampal CA3 and CA1 areas. However, in hilus, TBI animals showed 35-40% while PILO animals showed 70-75% cell loss. Only PILO animals exhibited mossy fiber sprouting into the inner molecular layer. This data suggests that TBI animals have a window of increased susceptibility to epileptic activity which decreases over time. Supported by NIH grants NS-32403 and PO1 NS-25630 to DAC, and NS-29995 to BGL.

PHARMACOLOGICAL INVESTIGATION OF NEW NICOTINIC ANALOGS AT THE $\alpha_4\beta_2$ RECEPTOR. Kimberly R. Creasy, M. Imad Damaj, and Billy R. Martin. Department of Pharmacology/Toxicology, Virginia Commonwealth University/Medical College of Virginia, Richmond, VA 23298. The predominant nicotinic acetylcholine receptor (nAChR) subtype found in mammalian brain is $\alpha_4\beta_2$ which therefore, may underlie several of the pharmacological effects of (-)-nicotine. The objective of this study was to identify the effects of nicotine mediated by this receptor subtype. Several novel nicotinic analogs were evaluated for receptor affinity (³H-nicotine binding), pharmacological potency (antinociception and locomotor activity) and current induction in *Xenopus* oocytes transfected with the $\alpha_4\beta_2$ subunits. Our results indicate that the analogs fall into one of three general categories: those similar to (-)-nicotine, such as epibatidine and isonicotine, which bind well to nAChRs, have their behavioral effects blocked by the nicotinic antagonist, mecamylamine and generate currents in oocytes injected with $\alpha_4\beta_2$ mRNA; secondly those, such as lobeline and N-ethyl-N-norisonicotine, which bind well, are not blocked by mecamylamine and do not illicit currents; and finally those, such as the bridged nicotine analogs and N-cyclopropylmethyl-N-nornicotine, which do not bind, yet produce behavioral effects insensitive to mecamylamine and do not induce currents in oocytes. These results suggest that binding affinity and sensitivity to mecamylamine are corequisites to $\alpha_4\beta_2$ receptor subtype binding while agonists with different profiles may associate with other nicotinic receptor subtypes. (Supported by PHS grant #DA-0527)

INFLUENCE OF EXOGENOUS UNSATURATED FATTY ACIDS ON *DE NOVO* SYNTHESIS OF SATURATED FATTY ACIDS IN MOUSE AND BOVINE MAMMARY CELL CULTURES. Shella E. Dawson & J. H. Herbein. Dept. of Dairy Sci., Va. Polytechnic Inst. & State Univ., Blacksburg, VA 24061. The capacity of mouse and bovine mammary cells to incorporate cis-9-octadecenoic (18:1), 9,12-octadecadienoic (18:2), 9,12,15-octadecatrienoic (18:3), or conjugated linoleic acid (CLA) into cell lipids was evaluated at 0, 12.5, 25, 50, and 100 μ M in the culture medium with 100 μ M 18:0. Fatty acid treatments were applied daily for 3 days to confluent cells on uncoated plastic petri plates. Data for cellular fatty acid content were expressed as μ g /mg protein. Mouse cells incorporated 18:1 and 18:2 to a greater extent than bovine cells; whereas, bovine cells incorporated 18:3 and CLA to a greater extent than mouse cells. Inhibition of *de novo* synthesis of 16:0 and desaturation of 18:0 to 18:1 were proportional to extent of 18:3 or CLA uptake by mouse and bovine cells. Due to the anticarcinogenic effects of CLA, which is a byproduct of ruminal biohydrogenation of 18:3 and 18:2, enhancement of the CLA content of bovine milk fat is desirable. Data suggest that bovine milk with increased 18:1, 18:3, and CLA content and decreased saturated fatty acid content can be produced if the supply of these unsaturated fatty acids to the mammary gland are increased. The lack of CLA uptake by mouse cells when CLA concentration in the medium was less than 100 μ M suggests that the capacity for enhancement of CLA content of milk of nonruminant species such as humans may be limited. (Supported by a scholarship and operating funds from the John L. Pratt Animal Nutrition Program, College of Agriculture & Life Sciences, Va. Polytechnic Inst. & State Univ.)

NICOTINE DISCRIMINATION IN RATS: CORRELATION WITH AFFINITY TO NICOTINE RECEPTORS IN THE BRAIN. Michael A. Dewey, Imad Damaj, John A. Rosecrans, Billy R. Martin. Department of Pharmacology/Toxicology, Virginia Commonwealth University/Medical College of Virginia, Richmond, VA 23298. Nicotine serves as a discriminative stimulus in conditioning experiments. Using rat discrimination model, we investigated the relationship between receptor affinity (^3H -nicotine binding) and pharmacological potency in nicotine-trained rats. Results were expressed as percent correct lever presses (% Test). Nicotine agonists of diverse chemical structure and receptor affinity were tested in this model. Nicotine fully generalized in nicotine trained rats with an ED_{50} of 0.1 mg/kg. Its effect was blocked by mecamylamine but not hexamethonium, a peripheral nicotinic antagonist. These results suggest the involvement of central nicotinic receptors in the nicotine cue. Furthermore, a high correlation coefficient was found ($r = 0.991$) between receptor affinity (K_1 values) and pharmacological potency (ED_{50} value) in nicotine-trained rats for various nicotine agonists tested. Our results suggest the involvement of neuronal nicotinic receptors containing $\alpha_4\beta_2$ subunits combination in nicotine discrimination stimulus. (Supported by PHS grant #DA-0527)

DELTA-9 THC ENHANCES THE BLOCKADE OF MECHANICAL NOCICEPTION BY MORPHINE. Ken L. Fujimori, Sandra P. Welch and Forrest L. Smith. Pharmacology and Toxicology, Medical College of Virginia/ Va. Commonwealth Univ., Richmond, Va. 23298. Morphine is one of most commonly used analgesic agents for pain management. However, in some cases morphine and other opiates used alone have been found to be ineffective in relieving chronic pain and other forms of resistant pain. Furthermore, patients often require increasing doses of morphine with long-term use, and high doses are associated with an increased incidence of unacceptable side effects. The use of Delta-9 Tetrahydrocannabinol (THC) as a therapeutic analgesic agent has been limited because of its psychoactive side effects. However, several studies indicate that inactive doses of THC can enhance the potency of morphine in tests of radiant heat nociception. This study was conducted to test the hypothesis that delta-9 THC enhances the potency of morphine against mechanical nociception. Antinociception was tested using the Ugo Basile test apparatus for mechanical nociception in the hind paw of Sprague Dawley rats. Simultaneous i.p. administration of vehicle and morphine produced an ED_{50} value for morphine of 5.0 mg/kg. Simultaneous administration THC (2 mg/kg) and morphine failed to significantly increase the ED_{50} value of morphine (ED_{50} 2.6 mg/kg). However, a 60 minute pretreatment of THC (2 mg/kg) produced an 8.9-fold increase in the potency of morphine ($\text{ED}_{50} = .44$). Our result support the potential value of combining THC and opiates for treating chronic or resistant pain. These data also indicate the importance of time of exposure for the enhancement to occur. In the future we would like study these drug combinations in the Freund's adjuvant chronic pain model.

DISCRIMINATIVE STIMULUS EFFECTS OF ANANDAMIDE AND METHYLATED FLUOROANANDAMIDE IN Δ^9 -THC-TRAINED MONKEYS. Keith M. Golden, Jenny L. Wiley, Raj K. Razdan*, and Billy R. Martin, Dept. of Pharmacol. & Toxicol., Va. Commonwealth Univ., Richmond, VA 23298 and Organix, Inc., Woburn, MA. In previous research anandamide has been shown to produce behavioral effects in mice characteristic of psychoactive cannabinoids and to substitute for Δ^9 -THC in rat drug discrimination. However, anandamide has a more rapid onset, lower potency, and a shorter duration of action than does Δ^9 -THC. The present study examined the discriminative stimulus effects of anandamide in rhesus monkeys trained to discriminate Δ^9 -THC from vehicle. Anandamide failed to produce reliable substitution for Δ^9 -THC and did not reduce response rates at doses up to 10 mg/kg. In a second investigation, the discriminative stimulus effects of methylated fluoroanandamide, a theoretically more stable form of anandamide, were investigated. Methylated fluoroanandamide produced full dose-dependent substitution for Δ^9 -THC and caused no significant changes in response rates at doses up to 0.3 mg/kg. These results suggest that anandamide may have been metabolized before behaviorally active concentrations could reach the brain and provide further support for anandamide's role as an endogenous cannabinoid ligand. (Supported by NIDA grants DA-03672 and DA-05488.)

EFFECTS OF MORPHINE ON EXTRANEURONAL LEVELS OF ASPARTATE AND GLUTAMATE IN THE NUCLEUS ACCUMBENS (NA). Valerie E. Hite, Dept of Bio.VCU, Richmond, Va. 23284, & Susan E. Robinson and Paul M. Kunko*, Dept of Pharm and Tox, VCU, 23298-0613. Excitatory amino acids(EAA), glutamate (GLU) and aspartate (ASP), occur in high concentrations in the brain and exert powerful stimulatory effects on neuronal activity. Previous investigations indicate that administration of cocaine increases ASP and GLU in the NA. The excitatory state associated with cocaine could be related to the motor effects observed with the drug instead of the reward pathway in the NA. Morphine has reinforcing effects similar to cocaine but does not increase locomotor activity, therefore we hypothesized that if there is an increase in the EAA after morphine injection, it is not precipitated by locomotor activity. Male rats were stereotactically implanted with a guide cannula in the region of the NA. Three treatment groups: saline (1 ml/kg), morphine (10 mg/kg), and cocaine (30 mg/kg) were studied. A microdialysis probe collected neuronal fluid in 10 minute fractions. Behavioral analysis was observed to quantify locomotor activity. Neurotransmitter analysis was achieved via a gas chromatograph/mass selective detector. Data interpretations indicate no statistically significant difference in behavioral analysis or the effects of morphine in EAA, ASP or GLU. These results are based on a N=2 (within each treatment group), therefore, all results could not be deemed statistically significant. Further analysis will be necessary to reach conclusive results.

BEHAVIORAL EFFECTS OF PERINATAL EXPOSURE TO 1,1,1-TRICHLOROETHANE IN MICE. Hendree E. Jones and R.L. Balster, Dept. Pharmacology and Toxicology, Medical College of Va.-Va. Commonwealth Univ., Richmond, Va. 23298. Studies of prenatal exposure to 1,1,1-trichloroethane (TCE) have focused on concentrations relevant to occupational use. Little is known about *in utero* exposure to TCE concentrations subject to abuse. Previous experiments have indicated that intermittent (8000 ppm for 60 min. 3 times/day) *in utero* exposure to TCE produces a pattern of developmental and behavioral delays. In order to better characterize a minimal exposure level necessary to produce behavioral teratology in offspring, dams were exposed to either 0 ppm, 350 ppm, 2000 ppm or 4000 ppm TCE 3 times per day for 60 min. during gestation days 12-17. No differences were seen in maternal weight gain, food consumption or initial litter variables of gestation length, litter size, litter weight or sex ratio. Nor were there differences between any of the TCE-exposed pups and sham-exposed pups on weight gain, eye opening, pinnae detachment, incisor eruption, righting reflex, rooting reflex or grip strength. Delays were observed between the TCE-exposed (4000 ppm) pups and sham-exposed pups on the negative geotaxis task and the inverted screen test on postnatal days 8 and 9. These data provide evidence for a concentration-effect relationship for the behavioral teratogenic effects of TCE and establish minimal exposures necessary for these effects. Taken together with results of other studies, evidence is emerging that there may be severe risks associated with TCE abuse during pregnancy. (Supported by NIDA grant DA03112 and pre-doctoral fellowship DA05665).

INTERPRETATION OF THE DIVERSE ACTIVITY OF ALLOSTERIC MODIFIERS OF HEMOGLOBIN ON THE BASIS OF X-RAY CRYSTALLOGRAPHIC ANALYSIS. Jayashree A. Kurup and Donald J. Abraham, Dept. Of Medicinal Chemistry, Va. Commonwealth Univ., Richmond, Va. The gem-dimethyl substituent of RSR 4 and RSR 13, potent allosteric modifiers of hemoglobin, was replaced by a methylene moiety, large cyclic and branched hydrophobic substituents such as cyclobutyl, cyclopentyl, cyclohexyl, isopropyl and 2,2-dimethylpropyl. The effect of these substituents on allosteric activity as measured by P_{50} , was correlated to the binding of these compounds to hemoglobin. The 3,5-dimethyl cyclopropyl carboxylic acid proved to be the best effector. X-ray analysis revealed a single pair of symmetry related binding sites for four of the six compounds studied in the central water cavity of hemoglobin. The effectors stabilize the deoxy conformation of hemoglobin by making interactions with three different subunits. These studies revealed that steric and entropic factors govern the binding of these analogs to hemoglobin and determine the degree of biological activity. No continuous electron density was observed for the des-methyl derivative or the bulky 2,2-dimethylpropyl analog.

ANANDAMIDE-INDUCED HYPOTENSION IS MEDIATED VIA PERIPHERAL CB₁ RECEPTORS. Kristy D. Lake, Karoly Varga*, and George Kunos*. Dept. Pharmacology and Toxicology, MCV-VCU, Richmond, VA 23298-0613. Cannabinoids affect blood pressure and heart rate in animals and humans, yet, relatively little is known regarding the mechanisms by which they produce these effects. Our previous studies in urethane-anesthetized rats, showed that anandamide (ANA) and Δ^9 -tetrahydrocannabinol (THC) elicit hypotension. We also have found that the magnitude of ANA-induced hypotension is dependent on the basal intrinsic sympathetic tone. We investigated the target site and mechanisms by which this hypotension is induced. Other research in our lab has indicated that ANA acts at the synaptic terminals of postganglionic sympathetic neurons, most likely the presynaptic membrane. To directly evaluate a presynaptic site of action, we utilized a tissue bath assay to measure electrically-evoked, vesicularly released ³H-noradrenaline (NA) from atria tissue. ANA and THC dose-dependently (0.3-10 μ M; $p < 0.05$) attenuated the % fractional release of electrically-stimulated, vesicularly released NA. This attenuation by ANA and THC was blocked by the CB₁ receptor antagonist, SR141716A (1-10 μ M). To further support our hypothesis that the CB₁ receptor is located on the presynaptic terminals of the postganglionic sympathetic neurons, we looked for message for the CB₁ receptor in the cell body located in the cervical sympathetic ganglia using RT-PCR. Gel analysis of the cDNA to the CB₁ primers showed bands in the cervical ganglia which hybridized to a ³²P-labeled probe for the CB₁ receptor. From these data we conclude that ANA activates CB₁ receptors located on the presynaptic nerve terminals of postganglionic sympathetic neurons. Activation of these CB₁ receptors attenuates vesicularly released NA, resulting in hypotension. The discovery of cannabinoid receptors in the periphery involved in sympathoinhibition provides an important starting point for further therapeutic development for antihypertensive agents.

MALONALDEHYDE AFTER 24 AND 48 HOURS OF PRESERVATION IN RAT SMALL BOWEL TRANSPLANTATION. K. L. Lewis, R. E. Sonnino, and R. Franson, Dept. of Biology, Division of Pediatric Surgery, and Dept. of Biochemistry, Va. Commonwealth Univ., Richmond, VA 23298. Small bowel transplantation is important in the treatment of short bowel syndrome in children; however, at the present time its use is limited. One problem is due to poor organ preservation and reperfusion injury during the transplantation. The long term objective of this project is to determine if prolonged storage of the viable small bowel in a solution known as UW (University of Wisconsin) prior to the transplantation is possible. The aim of this study centers around developing the appropriate solution to increase the time span for preservation of the small bowel before transplantation to 48 hours. In each experiment of our study, a MDA assay was run on each animal's blood sample and the UW solution that the bowel had been preserved in to establish a correlation between MDA levels and tissue injury. It was shown that storage does have some effects on MDA levels in the UW solution, used to store the bowel (preservation) before transplantation. It was also concluded that sites four through seven were probably segments that should be used in the transplantation procedures.

Ellagic Acid a Dietary Anticarcinogenic Phytochemical Does Not Protect Against Dermal Benzo(a)pyrene Induced Humoral Immune Suppression. G. Craig Llewellyn and Kimber L. White Jr, Dept. of Pharmacology and Toxicology, Med. Col. of Va., Va. Commonwealth Univ., Richmond, VA 23298. Suppression of immune function by environmental contaminants has been well documented. Among these contaminants are the polycyclic aromatic hydrocarbons (PAH's). Benzo(a)pyrene (BaP), a prototypical PAH, selectively inhibits humoral immune function, i.e. antibody formation. Ellagic acid (EA) is a phenolic compound isolated from fruits and nuts commonly found in the diet of humans. EA has been shown to protect from many types of cancers induced by environmental contaminants, including BaP. The objective of these studies was to evaluate potential protection from BaP-induced immunosuppression by EA. EA (30, 100, 300, 600, and 1000 mg/kg) administered daily to female B6C3F1 mice by oral gavage for 31 days did not affect IgM or IgG production to the T-dependent antigen sheep red blood cells (sRBC). However, a dose-dependent increase in hepatic glutathione S-transferase activity, a biomarker of EA exposure was observed. Oral EA (1000 mg/kg) co-exposed for 29 days with dermal BaP (0.625, 2.5, 5, and 20 mg/kg) in female B6C3F1 mice did not alter the BaP-induced suppression of the IgM response. Effects on the IgG response were inconclusive because the characteristic BaP-induced suppression not observed. *In vitro* evaluation of the T-dependent antibody response by Mishell-Dutton assay (10 nM - 10 μ M) demonstrated dose-dependent increases in the antibody forming cell (AFC) response. However, the increase did not reach the level of statistical significance. *In vitro* co-exposure of EA (10 μ M) and BaP (10 nM - 10 μ M) did not alter BaP-induced AFC suppression. Although EA has been shown to protect from BaP-induced carcinogenesis, EA appears not to provide protection *in vivo* or *in vitro* from BaP-induced suppression of the humoral immune response. Supported in part by NIEHS contract ESO 9522 and NIEHS training grant ESO 7087.

The Potential Use of Lymphocyte Phenotype from Draining Lymph Nodes of Xenobiotic Exposed Animals in Identifying Contact and Respiratory Sensitizers. T. Scott Manetz, A. E. Munson and B. Jean Meade*. Pharmacology and Toxicology, Med. Col. of Va./VCU, Richmond, VA. There remains a need to develop new methods for detecting chemicals capable of inducing respiratory and dermal sensitization. Studies are underway to investigate the potential use of flow cytometric analysis of draining lymph node memory B cell phenotype from xenobiotic exposed animals to differentiate between the two types of sensitizers. Using a known respiratory (Type I) sensitizer, toluene diisocyanate (TDI), and contact (Type IV) sensitizer, dinitrofluorobenzene (DNFB), phenotypic analysis was conducted on lymphocytes from animals following topical exposure to either xenobiotic for 4 consecutive days. Doses for sensitization, the maximal nonirritating concentration (MNC) and minimal irritating concentration (MIC), were identified based on an irritancy assay. The MNC and MIC for TDI were 1.0% and 2.5%, respectively and for DNFB were 0.10% and 0.15%. Both chemicals induced lymph node cell proliferation in the local lymph node assay (LLNA). Antibodies to CD3, CD4, CD8, B220, IgG_{2a}, IgM, and IgE were used for phenotyping. Differentiation between Type I (antibody mediated) and Type IV (cell mediated) hypersensitivity reactions could not be made based on these markers with one exception. The percent of IgE positive cells represents a potential marker for distinguishing the two responses. TDI (2.5%) exposed animals showed a four fold higher level of membrane IgE than DNFB (0.15%) exposed animals. In a time course study phenotyping cells between 6 and 14 days following initial exposure, an increase in IgE positive cells began after day 6, peaking on day 10. Based on these studies, it appears that phenotypic analysis of draining lymph node memory B cells in xenobiotic exposed animals 10 days post initial exposure may serve as an indicator of test article sensitizing potential. These studies were conducted at the Med. Col. of Va. Immunotoxicology Laboratory under NIEHS Contract ES 05288.

ACUTE INTRATHECAL ADMINISTRATION OF Δ^9 -THC INDUCES ANTINOCICEPTION IN CONJUNCTION WITH AN INCREASE IN SPINAL DYNORPHIN A (1-17) CONCENTRATION. David J. Mason and Dr. Sandra Welch, Department of Pharmacology and Toxicology, Medical College of Virginia/Virginia Commonwealth University, Richmond, Virginia 2329. Dynorphin A (1-17) and the κ_1 opiate receptor have been implicated as key components in the production of Δ^9 - THC - induced spinal antinociception. Using a spinal perfusion technique, the thoracolumbar cavity of male Sprague Dawley rats was rapidly perfused and the eluting CSF collected from the open cisternal space in conjunction with an assessment of tail - flick latency 3, 10, and 30 minutes post administration of Δ^9 - THC, CP55,940 or DMSO vehicle. Fractions collected 3 minutes post administration of Δ^9 - THC (300 μ g) exhibited a 5 fold increase in dynorphin A (1-17) levels in comparison to animals administered vehicle alone. A 12 fold increase was seen in spinal dynorphin levels 10 minutes post administration of 300 μ g Δ^9 - THC in comparison to animals receiving vehicle. Acute administration of CP55,940 (100 μ g) failed to increase spinal dynorphin levels. Dynorphin levels appeared unchanged 30 minutes post administration of Δ^9 - THC (300 μ g) in comparison to animals receiving vehicle. DMSO alone failed to significantly alter tail - flick latency. Δ^9 - THC (300 μ g) induced 58% MPE 10 minutes post administration and 100% MPE 30 minutes post administration. A 100 μ g dose of CP55,940 produced 100% MPE 10 minutes post administration. These data support a hypothesis suggesting that the development of Δ^9 - THC - induced antinociception in the spinal cord involves the release of the endogenous dynorphin A (1-17).

STRUCTURAL STUDIES OF HEMOGLOBIN-DRUG COMPLEXES. IMPLICATIONS FOR THE ALLOSTERIC MECHANISM. M. Carmen Moure, Donald J. Abraham, Dept. Of Medicinal Chemistry, Va. Commonwealth Univ., Richmond, Va. Allosteric effectors that stabilize the T (tense) state of hemoglobin have been synthesized and their activities measured as P_{50} values. Allosteric activity cannot be explained solely on the basis of their affinity binding constants. Previous crystallographic studies showed that these effectors bind at the same site in the hemoglobin central water cavity. Interaction with the binding site residue Lys99 has been proposed to contribute to the allosteric activity observed for the most potent compounds. To prove this, X-ray data was collected to 2Å resolution on complexes of hemoglobin with different allosteric effectors, and the data refined using native hemoglobin coordinates. Electron density maps showed additional binding sites in the central water cavity which were not observed previously for the most potent members of the series. Our results suggest that the new sites could be contributing to the increased allosteric activity by adding more constraints to the T state.

INTERLEUKIN-12 EXPRESSION DURING TUMOR GROWTH. D.W. Mullins and K.D. Elgert. Dept. of Biol., Va. Polytechnic Inst. and State Univ., Blacksburg, VA 24061-0406. Cancerous tumors use a variety of mechanisms to evade detection and destruction by the immune system, including production of elevated levels of inhibitory cytokines. Tumor-derived signals dysregulate immune balance, leading to altered immune cell function and compromised immune response to cancer. We have previously defined mechanisms by which tumor-bearing host (TBH) macrophages (M ϕ) mediate immunosuppression, in part, through increased production of cytokines which suppress T-cell responsiveness. Because the M ϕ -derived immunostimulatory cytokine interleukin-12 (IL-12) drives cell-mediated (T_H1-type) immune responses, and tumor growth compromises T-cell antitumor activities, we studied whether murine fibrosarcoma growth altered M ϕ IL-12 production. Using a novel IL-12-responsive T-cell line (Kit225/K6), we developed a bioassay for active IL-12. We report that tumor growth dysregulates M ϕ production of IL-12, which may partially explain tumor-induced immunosuppression. Further, these results suggest new immunotherapeutic approaches using IL-12 to reconstitute host antitumor responses. Supported by the Virginia Academy of Science Small Projects Fund, the Virginia Tech Graduate Student Association, and Sigma Xi.

EXPRESSION OF A CANNABINOID RECEPTOR USING THE SEMLIKI FOREST VIRUS. John M. Olson¹, Denise A. Dove Petti², Douglas L. Anders, and Guy A. Cabral, Dept. of Microbiology and Immunology, Medical Coll. of VA/VA Commonwealth Univ. Richmond, VA 23298-0678. Delta-9-tetrahydrocannabinol (THC), the major psychoactive component in marijuana, has been shown to elicit some of its effects through cannabinoid receptors CB1 and CB2, found in the brain and the periphery, respectively. Research in our laboratory has focused on the expression, isolation, and purification of these receptors in order to provide insight into receptor ligand interactions. The Semliki Forest Virus gene expression system is being used to express the human neural cannabinoid receptor, CB1. CB1 cDNA was sub-cloned from pSKCANR into the pSFV1 expression vector creating pSFV1-CB1. RNA transcribed *in vitro* from pSFV1-CB1 was co-transfected into BHK-21 cells with pSFV-Helper2 RNA to generate SFV-CB1 recombinant virus particles. ³⁵S methionine was used for metabolic labeling of CB1-recombinant virus-infected BHK-21 cells. Lysates of cells collected at various time points were separated by SDS-PAGE and subjected to autoradiography and western-immunoblotting. Novel protein species with relative molecular weights consistent with that for the CB1 receptor based on extrapolation of the cDNA coding sequence were observed. At later times (i.e., 15-20 h), larger molecular weight products were detected which may either represent receptors coupled with G-proteins or receptor dimers. These results suggest that the Semliki Forest Virus system may prove ideal for the production of preparative levels of CB1 receptor. Supported by NIH awards DA05832, DA09158, T32 AI07407¹, and T32 DA07027².

CHARACTERIZATION OF ACUTE TOLERANCE TO NICOTINE-INDUCED ANTINOCICEPTION IN MICE AFTER INTRATHECAL ADMINISTRATION. G.S. Patrick, M.I. Damaj, B.R. Martin, Dept. of Pharmacology and Toxicology, Virginia Commonwealth University, Richmond, VA 23298-0613. Acute tolerance to nicotine is believed to be a major factor in the development of nicotine dependence. It has been previously shown that acute tolerance develops to nicotine's pharmacological effect after subcutaneous injection in mice. The focus of this study was to investigate and characterize the development of acute tolerance to nicotine-induced antinociception following intrathecal (i.t.) injection using the tail-flick test. Using ICR mice, nicotine-induced antinociception was dose-dependent with an ED₅₀ of 10 μ g/mouse. Acute tolerance developed to nicotine after pretreating mice with inactive doses of i.t. nicotine. Tolerance peaked at 10 minutes after the pretreatment and dissipated 2 later. Pretreatment with higher doses of nicotine significantly extended the tolerance time course. Furthermore, acute tolerance to nicotine was blocked by an i.t. injection of mecamylamine, a nicotinic antagonist, suggesting the involvement of neuronal nicotine receptors in this phenomena. Finally, nicotinic agonists whose antinociceptive effects are blocked by mecamylamine, such as (+)-nicotine and epibatidine isomers, were found to be cross-tolerant to nicotine. In contrast, compounds which are not sensitive to mecamylamine, such as (+)-bridged nicotine and lobeline, showed no cross-tolerance to nicotine. Our data suggest that multiple mechanisms are involved in the development of acute tolerance to nicotine. (Supported by DA-0527)

2', 3'-DIDEOXYINOSINE INHIBITS THE HUMORAL IMMUNE RESPONSE IN FEMALE B6C3F1 MICE BY TARGETING THE B LYMPHOCYTE. Kathleen E. Phillips* and Albert E. Munson. Department of Pharmacology and Toxicology, Medical College of Virginia, Virginia Commonwealth University, Richmond, VA 23298. 2',3'-Dideoxyinosine (ddI) is a purine nucleoside analogue currently being used for the treatment of HIV positive individuals and patients with AIDS. Preliminary immunotoxicity studies have shown that a consequence of ddI treatment in female B6C3F1 mice is the inhibition of the humoral immune response. These studies were undertaken to investigate the immune cell target of ddI and to begin to determine the mechanism of this toxicity. B6C3F1 mice were treated with 1000 mg/kg/day by oral gavage for a treatment period of 28 days. The B lymphocyte was identified as the cellular target of ddI through separation-reconstitution experiments of the adherent and non-adherent cell populations and of the T and B lymphocyte populations. These studies revealed a deficit in the ability of the non-adherent cells from ddI-treated mice to mount a normal antibody response to sRBC. A further separation of the non-adherent cells into T and B cells revealed a decreased ability of ddI-treated B cells to develop specific humoral immunity. Additional studies were undertaken to determine the mechanism by which ddI is affecting the B cell. Surface marker analysis to show changes in the cell populations revealed no difference between vehicle and ddI-treated mice. Proliferation of the B cells was also unaffected as shown by stimulation with LPS and anti-IgM plus IL-4. These results indicate that the primary cellular target of ddI is the B lymphocyte and that, although ddI does not affect proliferation, its mechanism of toxicity may be through inhibition of differentiation and/or secretion in the B lymphocyte. Supported by NIH contract ES 9522.

CLEARANCE OF GROWTH HORMONE FROM THE BLOOD-VASCULAR SYSTEM IN NEPHRECTOMIZED RATS. Kathleen P. Phillips, Dept. of Biol., Va. Commonwealth Univ., Richmond, Va. 23284, & R.J. Krieg, Dept. of Anatomy, Va. Commonwealth Univ./Medical College of Va., Richmond Va. 23284. Children with kidney disease have been shown to have lower than normal growth rates despite elevated levels of GH circulating in the blood. Therefore, this experiment was designed to measure the clearance of GH in a uraemic rat model. Male rats were made uraemic by 5/6 nephrectomy (NX). Two other groups of rats were studied: sham-operated fed *ad libitum* (SH), and sham-operated pair-fed with nephrectomized rats (PF). Two weeks after 5/6 Nx, blood samples were taken via intra-atrial catheters. For sampling, octreotide was given to suppress GH release, and then ratGH was injected and periodic samples were taken. GH was measured in the plasma by radioimmunoassay. Concentration of GH was plotted against time to generate clearance curves. There was an increase in half-life of GH in NX rats as compared to both SH and PF rats. Further studies with slightly altered designs are being performed to confer results.

BIOCHEMICAL AND PHYSIOLOGICAL EFFECTS INDUCED IN MALE ACCESSORY SEX GLANDS BY 5- α -DIHYDROTESTOSTERONE AND THE EPIDERMAL GROWTH FACTOR. Ryan Phillips, Dept. of Chemistry, James Madison Univ., Harrisonburg, Va. 22801, & Derek Gingerich* and Treasure Sucheck, Dept. of Biol., Eastern Mennonite Univ., Harrisonburg, Va. 22801. The biochemical effects of 5- α -dihydrotestosterone (DHT) and the epidermal growth factor (EGF) on accessory sex gland tissue of male Swiss Webster mice were analyzed. Groups of prepubescent mice were injected with 1.0 mg of DHT and 50 μ g of EGF for ten days. The anterior prostate and seminal vesicle were removed and weighed. The tissues were homogenized. Soluble proteins were analyzed by SDS-PAGE. Polyamines were derivatized with dansyl chloride and separated by high performance liquid chromatography (HPLC). For the seminal vesicle and anterior prostate, DHT treatment significantly increased organ weights above the control group, whereas EGF treatment slightly enhanced the organ weights. For the seminal vesicle, DHT significantly increased the production of two proteins (10 kDa and 16 kDa). DHT and EGF did not have significant effect on the polyamine levels relative to the control group.

THE *LAC* REPRESSOR MOUSE. Heidi Scrable, Dept. of Neuroscience, University of Virginia, Charlottesville, VA 22908. The introduction of foreign genes and DNA fragments into the genome of the mouse has led to the elucidation of the function of many normal genes, and to an understanding of how mutations in particular genes disrupt phenotype. The ability to introduce exogenous DNA sequences that code for either normal or mutant gene products, however, has been limited so far to those which result in benign or sub-lethal phenotypic changes. In an effort to circumvent problems that arise from the unregulated expression of introduced sequences, we have been constructing a regulatable transgenic system that is based on the lactose (*lac*) operon of *E. coli*. Like analogous systems that use temperature sensitive mutations to study lethal mutations in bacteria and lower eukaryotes, this system would allow the introduction and analysis of embryonic lethal genes at the organismal level without compromising the viability of their host, thereby greatly expanding the repertoire of genes that can be altered and analyzed within the context of an organism closely related to the human. We have succeeded in producing two independent lines of homozygous *lac* repressor mice in which transgenes encoding the *lac* repressor (*lacI*) are transcriptionally active by altering either the genetic background or the DNA sequence of *lacI* itself. We are now ready to evaluate how well an experimental transposon can regulate gene expression *in vivo*.

EXPRESSION OF THE *LAC* REPRESSOR IN TRANSGENIC MICE. Wendy Siemon and Heidi Scrable, Dept. of Neuroscience, Univ. of Va., Charlottesville, Va. 22908. The *lac* repressor mouse is the key and final component of a system for regulating gene expression in the mouse that is based on the *lac* operon of *E. coli*. The focus of this project was to acquire detailed information about when and in which tissues and cell types the *lac* repressor is expressed in homozygous mice transgenic for a gene encoding the repressor (*lacI*) under the control of the human β -actin promoter. Using Northern blot analysis of total RNA extracted from tissues of adult mice, we found ubiquitous expression of the transgene that ranged from high (muscle, heart, and thyroid), to moderate (brain, testis, kidney, and spleen), to low (liver, ovary, seminiferous tubules, and lung). We confirmed this result in adult tissues using a combination of reverse transcription and polymerase chain reaction (RT-PCR), then extended this assay to detect expression in single embryos from e7.5 to e12.5, and in neonatal tissues. We found that the *lac* repressor is expressed in post-implantation embryos and in maternal decidual cells, but not in extra-embryonic tissues, at all embryonic stages analyzed. We also detected ubiquitous expression in neonatal tissues. These results establish a data bank of information about expression that will allow us to evaluate and interpret how well the *lac* repressor can regulate the expression of target genes in the transgenic mouse.

FOLLICULAR DENDRITIC CELLS (FDC) MAINTENANCE & RETENTION OF HIV INFECTIVITY. Beverly A. Smith, J. G. Tew, A. K. Szakal and G. F. Burton*, Dept. of Mic. & Immunol., Va. Commonwealth Univ., Richmond, Va. 23298. Infection with Human Immunodeficiency Virus (HIV) results in large amounts of virus being trapped on follicular dendritic cells (FDC) in germinal centers of secondary lymphoid tissues. Active infection is confined to these sites during the many years of clinical latency when the CD4⁺ T cell population declines prior to AIDS. Recently, we have shown that FDC trapped HIV is infectious and that infection persists even in the presence of a vast excess of neutralizing antibody. Since FDC retain conventional antigens in their native or unprocessed form for many months, we reasoned that FDC may not only retain HIV but also may maintain HIV infectivity for long periods. The objective of this present study was to determine how long FDC can retain HIV and maintain its infectious nature. We have devised a murine model for *in vivo* trapping of HIV on FDC under physiological conditions. Since the mouse is nonpermissive for HIV infection, no viral replication is possible *in situ*. Mice are passively immunized with Ab to HIV and injected in several sites with virus to allow immune complex formation and trapping on FDC in multiple draining lymph nodes. FDC bearing trapped HIV were isolated weekly. The amount of virus trapping was determined by p24 ELISA and the ability of that virus to cause infection was tested by coculture of the FDC with susceptible target cells. Infection was assessed by PCR for proviral DNA and by p24 production. Preliminary results indicated that FDC trapped HIV maintained its infectious nature well beyond the period predicted by *in vivo* half life studies on free virus in plasma. These data support our hypothesis that FDC retain HIV for long periods and maintain infectivity. This finding may have important implications for design of intervention strategies that can target this reservoir of infectious virus. (Support: NIAID Grant #32406 & MCV/VCU HIV/AIDS Center)

GONADAL STEROID REGULATION OF DENDRITIC MORPHOLOGY IN

PREGNANT RATS. G. Stafisso-Sandoz, C. Hearon, L. Keyser & C.H. Kinsley, Dept. of Psych., Univ. Richmond, Va, 23173. A newly-parturient female must be capable of learning a new repertoire of behaviors in order to adequately care for her offspring -- learning in which hippocampus (HI), a structure capable of hormone-induced plasticity during estrus (Wooley & McEwen, *J. Comp. Neurol.*, 336: 293-306; 1993), is involved. Pregnancy exposes a female to similar hormones for significantly longer; thus, we examined whether the hormones of pregnancy altered neurons of the CA1 region of the HI. Virgin females were ovx and sequentially-implanted with Silastic capsules containing progesterone and estradiol (11 days and 10 days, respectively) or blank capsules. Brains were removed, Golgi-stained and the primary branch of the apical dendrite of completely-stained HI-CA1 neurons was traced with oil-immersion at x1600 using Neurolucida. Dendritic spine density (# spines/10 μ m) was increased in hormone-treated females. Unpublished research from our laboratory has found that females with reproductive experience are capable of learning to run a maze better than their nulliparous counterparts. Therefore, pregnancy may alter a population of neurons relevant for maternal behavior-related learning.

MORPHINE DISRUPTION OF MATERNAL BEHAVIOR: MEDIATION THROUGH

REDUCTIONS OF C-FOS ACTIVATION. G. Stafisso-Sandoz, D. Polley, W. Carpenter, B. Holt, N. Jones, K.G. Lambert¹ & C.H. Kinsley, Depts. of Psych., Univ. Richmond, VA, 23173 and ¹ Randolph-Macon College, Ashland, Va, 23005. Morphine significantly impairs maternal behavior (MB); Naloxone, an opiate antagonist, restores it. MB is associated with c-fos expression in medial preoptic area (mPOA) of females. We examined the relative effects of morphine and Naloxone on the expression of this immediate early gene product. On postpartum day 5 or 6, females were injected with morphine or saline (Exp. 1), or morphine+Naloxone or morphine+saline (Exp. 2) and placed back in the homecage, separated from their pups by a wire-mesh partition. Sixty-minutes later processing for c-fos immunohistochemistry commenced. The c-fos positive cells in a proscribed portion of mPOA were then counted. Morphine-treated females had fewer c-fos cells in mPOA compared to saline-treated females. Further, morphine+naloxone-treated females expressed more c-fos cells compared to morphine+saline females. Morphine-treated females, therefore, may exhibit reductions in MB because of relative opiate-induced inactivation of areas of the brain devoted to the regulation of MB.

THE CHARACTERIZATION OF MALE ACCESSORY SEX GLAND PROTEINS INDUCED BY

5- α -DIHYDROTESTOSTERONE. Treasure Sucheck, Nate Derstine*, Trent Hummel* and Andrew Pennington*, Dept. of Biol., Eastern Mennonite Univ., Harrisonburg, Va. 22801. The 5- α -dihydrotestosterone (DHT) induced proteins in male accessory sex glands (ASG) were characterized. Prepubescent mice were injected with varying doses of DHT for 10 days. The anterior prostate (AP) and seminal vesicle (SV) were removed and weighed. The tissues were homogenized and soluble proteins were analyzed by SDS-PAGE. The SV and AP organ weights increased with increasing DHT dose. The expression of two proteins, (16 kDa and 10kDa) in the seminal vesicle and one protein (10 kDa) in the anterior prostate were influenced by the dose of DHT. Protein sequence analysis identified the 16 kDa SV protein as being "Seminal Vesicle Protein IV" (Chen et al.). The effect of endogenous testosterone on male ASG proteins was studied as the mouse developed through puberty. The SV and AP were removed and weighed from mice at the ages of 26, 30, 32, 24, 36, 40, 44, and 58 days. The tissues were homogenized and the soluble proteins were analyzed by SDS-PAGE. The SV and AP organ weights increased as the mouse went through puberty. The DHT induced seminal vesicle proteins (10 kDa and 16 kDa) were expressed by the age of 40 days. The DHT induced 10 kDa anterior prostate protein was not expressed by 58 days of age.

MOLECULAR CHARACTERIZATION OF COMPLEMENT RESISTANCE IN PATHOGENIC *NAEGLERIA FOWLERI* AMOEBAE. D. Toney*, D. Anders*, G. Cabral, F. Marciano-Cabral. Dept. of Micro. & Immuno. and E. Westin*, Dept. of Med., Div. of Hematology and Oncology, Med. Col. of VA/VCU, Richmond, VA 23298. *Naegleria fowleri* is the etiological agent of primary amoebic meningoencephalitis, a fatal central nervous system disease. The ability of pathogenic *N. fowleri* to evade host immunity and resist complement-mediated lysis is believed to be an important determinant of virulence. Enzymatic treatment of complement-resistant *N. fowleri* increased susceptibility to complement implicating a cell surface protein in the mechanism of complement resistance. Regulatory proteins, specifically CD59, have been shown to protect eukaryotic cells from complement-mediated destruction. In the present study, Northern analysis and reverse transcription-polymerase chain reaction (RT-PCR) were employed to establish whether pathogenic *N. fowleri* possess CD59 homologous transcripts. Northern analysis of *N. fowleri* total RNA revealed the presence of a 2 kb RNA species which hybridized to a human CD59 cDNA probe. RT-PCR employing degenerate oligonucleotide primers homologous to highly-conserved sequences between human and rat CD59 resulted in the amplification of three products of 344, 241, and 147 basepairs from *N. fowleri* RNA. Each of these products was cloned and subjected to DNA sequence analysis. One clone, pMP18, containing the 344 bp product, possessed 43% nucleotide identity and 26% amino acid identity with human CD59. Northern analysis of *N. fowleri* RNA demonstrated that pMP18 hybridized to a 2 kb RNA transcript suggesting that pMP18 may represent a *Naegleria*-specific homolog to human CD59. (Supported in part by NIH grants AI-27807 and DA-05832).

NEUROLOGIC DEFICITS AFTER CARDIOPULMONARY BYPASS SURGERY: AN EXPERIMENTAL MODEL. Anubha Tripathi, Chris Kyrus*, Andrew Beaumont* and Anthony Marmarou*, Dept. of Neurosurgery, Va. Commonwealth Univ., Richmond, Va. 23298. The leading source of morbidity and disability in cardiac surgeries is cerebral complication. Although several clinical studies have reported post-operative neurological deficits associated with cardiopulmonary bypass surgery, only a few experimental laboratory studies have attempted to duplicate the deficits in the laboratory setting. The present study focused on developing a model for investigation of neurologic deficits occurring after cardiopulmonary bypass surgery. The development of this model in the rat involved simulating the conditions under which cardiopulmonary bypass surgery is performed in humans. The model was subjected to conditions of hypothermia, hemodilution, and opening of the thoracic cavity with simultaneous monitoring of various parameters including arterial blood pressure, brain and core temperatures, sampling of blood gases, and EKG. This study establishes the feasibility for developing a rodent model useful in research of cerebral insufficiency following cardiac bypass operation.

A POSSIBLE PHOSPHATE AND THREONINE INTERACTION IN N-ASPARAGINE GLYCOSYLATION: A MOLECULAR MODELING APPROACH. Catherine W. White, Dept. of Pharmacology and Toxicology, Va Commonwealth Univ., Richmond, VA 23298-0613. Asn-Xxx-Ser/Thr (Xxx is any amino acid except proline) is a necessary sequence for transfer of an oligosaccharide from a dolichol pyrophosphate to the asparagine nitrogen in a protein. Why a threonine or serine is required has never been satisfactorily explained. Molecular modeling was used to investigate the spacial possibility of interaction between the alpha phosphate and the hydroxyl of the threonine. This was done by comparing these distances with Asn-Leu-Thr and Asn-Pro-Thr after minimizing energies. The distance with the Leu peptide is 4.14Å as compared to 7.97Å with the Pro peptide. (Supported in part by USPH grant T32-DA-07027.)

ANTI-ESTROGENIC COMPOUNDS IN WINE. R.L. Williams, Mark Elliott, Old Dominion University Enological Research Facility, Dept. of Chem./Biochem., Old Dominion Univ., Norfolk, Va. 23529, & R.Perry, Division of Surgical Oncology, Dept. of Surgery, Eastern Virginia Medical School, Norfolk, Va. 23508. Trans-resveratrol (trans-3,4',5'-trihydroxystilbene) has been described as a phytoalexin or anti-fungal agent in a variety of grapes. It has also been described as a potent inhibitor of protein-tyrosine kinase. Based on the structural similarity of this compound to the estrogenic agent diethylstilbestrol (DES), we have initiated a study of the potential estrogenic activity of this compound. Our preliminary results show that trans-resveratrol effectively binds to both the estrogen type I receptor as well as the estrogen type II receptor in MCF-7 human breast cancer cells. Using estrogen positive MCF-7 cells and estrogen negative MDA-231 cells, we have shown that trans-resveratrol is cytotoxic in both cell lines. The 50% inhibitory concentrations of trans-resveratrol were 14.2 ± 2.0 ug/ml for the MCF-7 cells and 10.5 ± 2.4 ug/ml for MDA cells. Trans-resveratrol has recently been described as a component in red wine. Based on the literature values of the levels of trans-resveratrol in various red wines, we would suggest that moderate consumption of red wine (400 ml) would provide approximately 250-260 ug of this agent. Assuming a 20% absorption rate, this volume of red wine should provide approximately 53 ug of trans-resveratrol to the consumer. Although this concentration would not fall in the cytotoxic range, this amount of trans-resveratrol may influence or antagonize estrogen binding and provide some beneficial effects in areas such as breast cancer.

THE ISOLATION AND KINETICS OF POLYPHENOLOXIDASE. Armando Wyatt and H. Alan Rowe, Department of Chemistry, Center for Materials Research, Norfolk State University, Norfolk, Virginia 23504

Polyphenoloxidase (PPO) is the enzyme responsible for the browning of fruit. Aromatic 1,2-dihydroxy compounds are oxidized and ultimately result in the production of melanin. An isolation procedure for PPO from the South American cavendish banana was developed and the kinetics of this enzyme was studied using catechol and dopamine as substrates. The K_m and V_{max} for the enzyme with these substrates were determined with crude and purified PPO. The enzyme assay was optimized and the effects of non-aqueous solvents initiated. Long range plans include the use of this enzyme in organic synthesis reactions and the comparison of the kinetics and structure of the PPO from this banana with the multiple Sri Lankan varieties. Supported by CMR-NSU.

Microbiology and Molecular Biology

METALLOTHIONEIN IN MARINE SYNECHOCOCCUS SPP. Arunsi C. Brown, Patricia A. Pleban¹, and Andrew S. Gordon², Dept. of Biol. Sci., and ¹Dept. of Chemistry., Old Dominion Univ., Norfolk, Va 23529. *Synechococcus* spp. are abundant in oceanic ecosystems and are responsible for a significant fraction of oceanic primary production. The levels of free cupric ion in surface seawater are close to the toxic threshold for marine cyanobacteria. Therefore we are interested in the interaction between marine *Synechococcus* and copper. Marine cyanobacteria have previously been reported to produce metallothionein (mt) under cadmium and zinc, but not copper, stress. Mt is believed to mediate metal detoxification. In this study we found that copper can induce two strains of marine *Synechococcus* spp. to produce <10,000kDa (mt-like) protein within 2 hours of copper exposure. This is, to our knowledge, the first report of mt induction by copper in marine *Synechococcus* spp.

BEHAVIOR OF *NAEGLERIA GRUBERI* IN VISCOUS FLUIDS. Stephen Gallik and A. Moshos*, Department of Biological Sciences, Mary Washington College, Fredericksburg, VA. 22401. The viscous drag experienced by cells crawling on solid surfaces is thought to be a major physical force on the cell surface. Yet, we know very little about the effect of fluid viscosity on the behavior of crawling cells. The principal objective of this study is to determine the effect of fluid viscosity on the proliferation and viability of the freshwater/soil protist *Naegleria gruberi* in preparation for future investigations on cell adhesion and movement. Series of flasks were seeded with *N. gruberi* cells at a density of 16,000 cells/cm². The culture medium was then changed to one of three media varying in viscosity: 0.8, 10 and 50 centipoise (cp). Viscosity of the culture medium was enhanced through the addition of methylcellulose. Cell number and cell viability were determined at 24 hour intervals for a period of 5 days. Methylcellulose-enhanced fluid viscosity of up to 50 cp had no effect on the viability of these cells. The population doubling time for all three groups was approx. 12 hours. Methylcellulose-enhanced fluid viscosity had a small effect on the population plateau density. (Supported by a grant from Mary Washington College.)

THE ROLE OF PROHIBITIN IN BREAST CANCER. J.Keith McClung*, Eldon Jupe, Robert Dell'Orco. *Radford University, Radford VA 24142, Oklahoma Medical Research Foundation, Oklahoma City, OK, 73104. Prohibitin is a putative tumor suppressor gene, is an evolutionarily conserved with homologues isolated from organisms ranging from yeast to man, is a gene with antiproliferative activity in mammalian cells, is required for the proper development of *Drosophila*, and is associated with the development of sporadic breast cancer. Our preliminary studies using breast cancer cell lines and breast tumor samples show that 80% of the samples are homozygous for one of the prohibitin alleles, the B type. Preliminary structural and functional studies also found a linkage between alterations in the 3' untranslated region (3'UTR) of the prohibitin gene and the disease state. The inhibitory activity was found to be in the 3'UTR and not in the protein coding region of the mRNA. Breast cancer cell lines and breast tumors which were homozygous for the B type allele were found to have mutations in this 3'UTR. In addition, these mutants did inhibit growth in control cells using our microinjection-based growth assay. Therefore, the 3'UTR may be involved in the development of breast cancer.

UNUSUAL RNA STRUCTURES ISOLATED FROM THE ARCHAE-BACTERIUM *SULFOLOBUS SOLFATARICUS*. Sarika Z. Singh and Thomas O. Sitz, Dept. of Biochem., Virginia Tech, Blacksburg, VA 24061. The examination of 30 *Sulfolobus* mRNA sequences in GeneBank did not find a Shine-Dalgarno Sequence (-AGGAGGU-) or any consensus sequence complementary to the 3'-end of 16S rRNA. How do ribosomes bind to mRNA in *Sulfolobus*? Are "cap like" (GpppNp-) structures found in *Sulfolobus* RNA? Recently *Sulfolobus* has been classified as an Eocyte, a microorganism more closely related to eucaryotes than other archaeobacteria. Whole cell RNA from *Sulfolobus* and yeast was digested with 0.3N NaOH. The alkaline resistant fragments were isolated and radioactively labeled by treatment with periodate followed by reduction with (3H)NaBH₄. Both RNA samples contained a possible "cap like" structure as characterized by DEAE-Sephadex column chromatography. A method using HPLC anion exchange column chromatography was developed to characterize these unusual RNA structures.

Natural History & Biodiversity

TEMPORAL VARIATION IN SHREW ASSEMBLAGES: A PITFALL REMOVAL

STUDY. Charlene R. Couch and John F. Pagels, Dept. of Biology, VA Commonwealth Univ., Richmond, VA 23284. We examined temporal and spatial distribution of five species of shrews collected by the use of pitfall traps with drift fences in five forest stands of different ages on Shenandoah Mountain, Virginia. All species, Sorex cinereus, S. hoyi, S. fumeus, S. dispar and Blarina brevicauda, were collected in all stands. S. cinereus was most abundant in all stands. Captures increased gradually from early spring with the exception of S. dispar, which was not caught prior to July. Captures in all stands rose in late spring, particularly in the clearcut, and were highest in late summer to early autumn. Captures of S. cinereus were greatest in August, while the remainder of the species peaked in October. There were very few captures of any species during the coldest winter months. These temporal variations in shrew captures illustrate the importance of selectively trapping in late spring and during late summer to early fall in order to maximize trapping success.

COMMUNITY STRUCTURE OF AN ANURAN COMMUNITY AT FORT A. P. HILL, VIRGINIA. Mark Dunaway, Barry Knisley, Dept. of Biol., Randolph-Macon Col., Ashland, VA 23005, and Joseph C. Mitchell, Dept. of Biol., Univ. Richmond, Richmond, VA 23173. Habitat, microhabitat, and seasonality were studied for nine species of anurans at seven sites at Fort A. P. Hill, Caroline Co, VA from March to August, 1995. A spring (March to April) active group included three species (R. palustris, B. americanus, P. crucifer) and a summer (May to September) active group included the remaining six species (R. clamitans, R. catesbiana, R. virgatipes, B. woodhousei, H. chrysoscelis, A. crepitans). Only R. clamitans, R. catesbiana and A. crepitans had overlapping microhabitats during the same season. R. palustris moved from its vocalizing microhabitat when R. virgatipes began calling. The two largest permanent ponds had the most species (7 and 8) and small temporary ponds the fewest species (2-4). There was no observed relationship between vegetation around the pond perimeter and the species' distributions. Among species which co-occurred spatially and temporally, there were apparent differences in microhabitat, diet, and predator defense mechanisms that may serve in niche segregation within this anuran community.

CONSERVATION PLANNING FOR NATURAL AREAS IN THE CITY OF VIRGINIA BEACH: A COOPERATIVE VENTURE. Sandra Y. Erdle, Dept. of Conservation and Recreation, Division of Natural Heritage, 1500 E. Main St., Richmond, Va. 23219 & H. Clayton Bernick III*, City of Virginia Beach, Environmental Management Ctr., Virginia Beach, Va. 23456. An inventory of Virginia Beach, by Dept. of Conservation and Recreation, Division of Natural Heritage revealed 77 rare plant species, 29 rare invertebrate species, 11 rare vertebrate species and 17 rare community types. A cooperative venture between the Div. of Natural Heritage and the City of Virginia Beach resulted in conservation planning for 11 identified high priority natural areas. Conservation planning integrates available information for specific sites through an analysis of ecological information, land uses and stewardship needs. A stress assessment, management and protection recommendations are compiled for natural areas within refined conservation planning boundaries. This information is intended to facilitate planning and land use decisions, to guide endeavors to actively protect natural diversity and to increase awareness regarding regional biodiversity issues. (This project was funded in part, by the Va. Dept. of Environmental Quality's Coastal Resources Management Program, pursuant to a grant from the Nat. Oceanic and Atmospheric Administration, Office of Ocean and Coastal Resource Management, under the Coastal Zone Management Act of 1972, as amended. Additional funds were provided by the City of Virginia Beach.)

ARTHROPOD INHABITANTS OF THE PITCHERS OF *NEPENTHES MIRABILIS* FROM FAR NORTH QUEENSLAND, AUSTRALIA. Norman J. Fashing, Dept. of Biology, Col. Of William and Mary, Williamsburg, Va. 23187. The genus *Nepenthes*, the eastern tropical pitcher plant, contains about 80 species scattered throughout the tropics of the Old World. Members of this genus are characterized by leaves with tips modified into pitchers designed to lure and trap insects which are digested in the pitcher liquid. A number of arthropod species, primarily flies, have adapted to live in the apparently inhospitable environment of the pitcher fluid. A sample of thirty-nine pitchers from *N. mirabilis* collected near Weipa, Far North Queensland, Australia, were found to contain species from seven arthropod families (numbers indicate percentage of pitchers inhabited followed by mean relative abundance excluding mites): Insecta, Diptera - Ceratopogonidae (*Dasyhelea*? sp., general saprophage, 89.7%, 0.5758), Sarcophagidae (*Sarcosolomonina papuensis*, macrosaprophage, 33.3%, 0.0198), Phoridae (*Megaselia*? sp., macrosaprophage, 20.5%, 0.0274), Culicidae (*Tripteroides* sp., macrosaprophage, 92.7%, 0.3448), Cecidomyiidae (*Lestodiplosis*? sp., predator, 12.8%, 0.0237), Chironomidae (*Pentaneura*? sp., top predator, 2.6%, 0.0086); Acarina, Astigmata - Histiogastromatidae (*Zwickia* sp. 1, macrosaprophage; *Zwickia* sp. 2, macrosaprophage; *Creutzzeria* sp., macrosaprophage, 84.6%). Members of the genus *Zwickia* were found in 92.3% of the pitchers examined.

ECOLOGICAL LANDSCAPE UNITS OF THE LAUREL FORK AREA IN HIGHLAND COUNTY, VIRGINIA: AN OVERVIEW. Gary P. Fleming and William H. Moorhead, Va. Dept. of Conservation and Recreation, Div. of Natural Heritage, Main Street Station, 1500 E. Main St., Suite 312, Richmond, VA 23219. Situated in northwestern Highland County, the Laurel Fork area is a high elevation region which supports several significant natural communities and more than eighty occurrences of state-rare plants and animals. In 1994, DCR-DNH entered into a cooperative agreement with the George Washington National Forest to classify, describe, and map ecologically distinct landscape units of this area. Environmental, vegetation, and floristic data were gathered from reconnaissance surveys and 50 permanent sampling plots, providing the basis for a classification of plant communities. The community classification was then synthesized with information on geology, geomorphology, soils, and land use history to produce an ecological land unit classification following methods developed by the Forest Service. The Laurel Fork area straddles the boundary between two major ecoregional units, the Allegheny Mountains and the Northern Ridge and Valley. The Allegheny Mountains barely enter Virginia and support northern land types of relatively limited extent in the Commonwealth, while oak-ericad land types prevail over the Ridge and Valley region. The final classification described 20 Landtype Phases, each more or less equating to a plant association and its habitat. These units were mapped using field data and aerial photographic overlays. This study provides practical tools for ecosystem-based land management, as well as methodologies which can be applied to classify and map similar terrain in the George Washington and Jefferson National Forests and beyond.

RECOVERY OF UNIONID MUSSELS IN THE NORTH FORK HOLSTON RIVER DOWNSTREAM OF SALTVILLE, VA. William F. Henley and Richard J. Neves. Dept. of Fisheries and Wildlife Sciences, Virginia Tech, Blacksburg, VA 24061-0321. The freshwater mussel fauna of the North Fork Holston River (NFHR) downstream of Saltville, VA declined from at least 24 species, as observed in 1918 to 1 in 1974 possibly due to mercury pollution. To determine the degree of recovery of mussels in the NFHR downstream of Saltville, VA 19 sites were surveyed using a snorkeling catch-per-unit-effort (CPUE) method. At sites where investigator CPUE values (no./h) equaled or exceeded 5 mussels/h, a CPUE survey was conducted along transect lines. If investigator CPUE values equaled 10/h, a quadrat survey was also conducted on transects. Nine species of mussels were observed in the NFHR, and reproduction, as indicated by the presence of juveniles, was noted at 5 sites. The number of mussels collected at sites, random CPUE (no./h), transect CPUE (no./h), and density (no./0.25m²) was generally inversely correlated to total mercury content, but not methylmercury content, as measured in *Corbicula fluminea* from proximate NFHRM sites. Random and transect CPUE (no./h) were found to be poor predictors of site densities (no./0.25m²) and population estimates. Translocation recommendations for the NFHR downstream of Saltville, VA were made based on multiple species aggregation, occurrence of multiple age classes for multiple species, reproduction, and the distribution of total mercury for NFHRM 56.4, 53.2, and 13.5.

PLOVER PARADISE: BARRIER ISLAND NESTING SURVEYS. Teta Kain, 7083 Caffee Creek Lane, Gloucester, Va. 23061. The barrier islands of Virginia comprise the most extensive and suitable habitat for nesting activities of both the Piping (*Charadrius melodus*) and Wilson's (*C. wilsonia*) plovers in Virginia. From the time that the Piping Plover was listed as a threatened species in 1986, the Va. Dept. of Game and Inland Fisheries have monitored nesting success of these two species. Populations of both species have dipped precipitously over the years, due to a number of factors. Mammalian and avian predators, human disturbance to nesting birds, and nesting habitat loss have all been major contributors to the species' decline. The areas of suitable habitat on Cedar and Metompkin islands are examined and methods of monitoring are explained. An overview of other avian species that nest on the islands is also presented.

AN UPDATE OF RANEY'S 1950 ACCOUNT OF FRESHWATER FISHES OF THE JAMES RIVER BASIN. Eugene G. Maurakis, Museum Scientist Dept., Science Museum of Virginia, Richmond, VA 23220, and William S. Woolcott, Biology Dept., University of Richmond, Richmond, VA 23173. Objectives are to provide a current list (and prevailing nomenclature) of freshwater fishes in the James River basin, and update discussions on the origin and relationships of the James River ichthyofauna, and the distributions of fishes within the system. The James River drainage contains 108 freshwater species (59 genera) in 21 families of fishes (81 native and 27 introduced species), including three endemics, two species (*Notropis semperasper* and *Etheostoma longimanum*), and one subspecies (*Percina notogramma montuosa*). The Piedmont contains the highest number (85) of species followed by Coastal Plain (75) and Montane (67). The high number of native species in the James River is attributed to acquisition of species from different origins and by different mechanisms. Phylogenetic relationships of native fishes by family are required to test earlier hypotheses that the James River drainage is more closely related to northern drainages (i.e., York and northward) than to southern ones (i.e., Roanoke and southward).

ESTABLISHING AMPHIBIAN MONITORING SITES ON THREE MILITARY BASES AND TWO NATIONAL PARKS IN VIRGINIA. Joseph C. Mitchell, Dept. of Biol. & School of Continuing Studies, University of Richmond, Richmond, VA 23173. The causes of amphibian decline worldwide are many and varied, but stem from the fact that these animals have dual life histories, aquatic and terrestrial. Two environmental factors apparently contribute to amphibian decline in the mid-Atlantic region, habitat loss and acid precipitation. Long-term monitoring sites were established in Ft. Belvoir, Quantico Marine Corps Base and Prince William Forest Park, Ft. A.P. Hill, and Shenandoah National Park in 1995. Seven wetland sites were selected for study in the military bases, as were three streams in Shenandoah National Park. I used two monitoring protocols in the military bases, nighttime frog call surveys and larval surveys. Time constrained searches and linear transects with m² quadrants were used in the mountain streams. Results to date reveal healthy populations of all species expected for the sites. Nighttime call surveys combined with larval surveys provide the most complete assessments of amphibian communities. Populations of salamanders in a stream with the lowest pH had the highest species diversity compared to other streams with higher pH values. Such information on amphibian communities provides robust assessments of the quality of wetland habitats that can be used by resource managers to make informed decisions about activities that may affect these animals. [Funding provided by the Legacy Resource Management Program of the US Dept. of Defense]

EFFECTS OF TIMBER HARVESTING ON PEAKS OF OTTER SALAMANDER (*PLETHODON HUBRICHTI*) POPULATIONS. Joseph C. Mitchell, Dept. of Biol., Univ. of Richmond, Richmond, VA 23173, Jill A. Wicknick* and Carl D. Anthony*, Dept. of Biol., Univ. of Southwestern Louisiana, Lafayette, LA 70402. The Peaks of Otter salamander is endemic to a small portion of the Blue Ridge Mountains of Virginia above 443 m elevation. Much of its range lies within a high timber producing region in the George Washington-Jefferson National Forest. We studied 23 sites that received either different types of forest management (clearcuts, shelterwood cuts) or were not recently logged. Densities were determined by counting the number of surface active salamanders in 1x50 m transects at night in wet weather. Densities are highest in areas supporting mature hardwoods. Populations were reduced by 45-47% in clearcuts and 10-66% in shelterwood cuts, as compared to mature sites. Variation in shelterwood cut densities were due to the number of canopy trees left standing. We obtained data on prey consumed by stomach flushing. We identified 949 prey from the stomachs of 80 salamanders from 20 sites. Ants and collembolans made up 54.5% of all prey items. Salamanders in mature sites consumed significantly more soft-bodied prey than in recent clearcuts and shelterwood cuts. Numbers of hard-bodied prey did not differ among sites. Timber harvesting practices may not eliminate this species but may diminish population densities and diet quality.

BEHAVIORAL PLASTICITY IN EGG CAPSULE DEPOSITION OF THE MUD SNAIL *ILYANASSA OBSOLETA*. Ronald S. Mollick, Dept. of Biol., Christopher Newport Univ., Newport News, Va. 23606. *Ilyanassa obsoleta* is abundant in both subtidal and intertidal regions of the York River. I hypothesized that egg capsule deposition by intertidal snails would be interrupted and reduced on collecting devices by falling tides in the field and on aquarium walls by tidal simulations in the laboratory. In the field, egg capsule collection devices were placed in intertidal and subtidal areas in the spring of 1986 and 1987. Capsule number, condition, and specific location on the device was noted after four weeks. In addition, snail density near each device was assessed. In the laboratory, sets of 30 snails were placed in aquaria that simulated either an intertidal or subtidal regime in the spring of each year and egg capsule number and location were assessed after four weeks. Field results showed that snails preferred to deposit capsules subtidally and in areas on the sampling devices which were closest to the substrate. This paralleled laboratory results. Collectively the behavioral plasticity of the snail allowed it to adjust egg capsule deposition behavior so as to maximize apparent survival of embryos.

MORPHOLOGICAL CHANGE IN GROWTH OF THE *TRICERATOPS* NASAL HORN. Christopher M. Morrow and John W. Happ, Natural Sciences and Mathematics Div., Shenandoah Univ., Winchester, VA 22601. An ontogenetic series of *Triceratops* nasal horncores from the Hell Creek Formation are analyzed to clarify mode of growth. Morphologies of a rare juvenile horn and a rare subadult horn are described for the first time. Comparisons are made with adult nasal horncores. *Triceratops* nasal horncores are identified by laterally compressed conical shape and epinasal ossification within the arch of an arcing vessel trace whose apex bisects the frontal surface. The small juvenile horn maintains a cancellous surface with only few vessel traces and beginning signs of epinasal ossification. The subadult horn has developed a layer of compact bone over a spongy interior, deep vessel traces, and more pronounced epinasal ossification. At bottom of both horns, a rugose basal suture is clear and distinct and shows major and minor foramina as well as a positive medial V-groove that fits between paired nasals. Neither juvenile horn nor subadult horn were permanently attached to a skull. The ossification process that permanently locks the horn to the nasals begins after the horn is of mature size. Discovery of basal sutures in juvenile and subadult horns confirms that the *Triceratops* nasal horn develops from a separate center of ossification rather than from an outgrowth of the paired nasals as in other Ceratopsidae. A bivariate log-log plot of basal length versus basal width of nasal horncores indicates positive allometry. The rate of rostrocaudal growth exceeds that of lateral growth.

THE WATER SHREW, SOREX PALUSTRIS, AND ITS HABITAT IN VIRGINIA. John F. Pagels, Leonard A. Smock, and Stephen H. Sklarew*, Dept. of Biology, Virginia Commonwealth Univ., Richmond, VA 23284. The water shrew was first collected in Virginia in Bath County in 1972 and placed on Virginia's list of endangered species in 1990. As part of a recovery effort, additional habitat has been identified and surveyed, and the water shrew has been found at four additional localities, all in Highland County. All five sites are small, headwater streams at an altitude above 900 m. Forest types were northern hardwood or northern hardwood and conifer. The streams are characterized by a steep slope and a resulting geomorphology of primarily riffles with occasional pools. The streams present a heterogeneous environment in terms of water depth, water velocity, substrate particle size and the presence of woody debris. Channel bank areas, the critical habitat for the water shrew, are stable, vegetated, frequently undercut and in direct contact with the stream water, providing the shrews with direct, protected access to the stream. The streams harbor a diverse and abundant aquatic macroinvertebrate community, the primary food of the shrews. (Supported by funds to J. Pagels from the Nongame and Endangered Species Program of the Virginia Department of Game and Inland Fisheries)

FLORISTIC DIVERSITY OF SEASONAL PONDS NEAR GRAFTON, YORK COUNTY, VIRGINIA. Thomas J. Rawinski and Tresha S. White*, Va. Dept. of Conservation and Recreation, Div. of Natural Heritage, Main Street Station, 1500 E. Main St., Suite 312, Richmond, Va. 23219. Virginia's most significant Coastal Plain seasonal ponds occur near Grafton in York County. The purpose of our study was to document vegetation patterns within and among ponds, leading to a better understanding of the ecological factors influencing floristic diversity and rare species distributions. Transects consisting of permanent, contiguous 100 m² plots were established across 35 ponds. Vascular plant species richness among 170 plots ranged from one to 39 taxa. Richness per pond ranged from 17 to 54 taxa, and the total flora consisted of 124 taxa. Five major plant communities were classified, each reflecting particular hydrologic conditions. Floristic diversity in a pond was largely a function of the number of communities present. Virginia's only known extant populations of *Fimbristylis perpusilla* and *Litsea aestivalis* occur here. Ponds disturbed by logging or mowing contained 20 plant species rarely if ever found in undisturbed ponds. In 1995 only five of the 35 ponds retained water past 28 June. Water levels are presently very high, and resampling in 1996 may document longer periods of inundation and changes in community composition.

ARE PITCHER PLANTS A COMPETITIVE THREAT TO THE NEW JERSEY RUSH, *JUNCUS CAESARIENSIS* COVILLE? Philip M. Sheridan, Dept. of Biol., Virginia Commonwealth Univ., Richmond, VA 23284. The VA Dept. Of Conservation and Recreation has suggested that a competitive interaction may occur between out-planted *Sarracenia* pitcher plants and the New Jersey Rush. For interspecific competition to occur there must be a shared, limiting resource and reduction of fitness in the presence of the presumed competitor. Light and nutrient appear to be the main limiting resources to these herbaceous species. Light is limited by shrub encroachment and not an interaction between the two species. Two introductions of *Sarracenia purpurea* to New Jersey Rush bogs in Caroline County, Virginia have resulted in increased fitness of both species. These results may be explained by a commensal relationship in which *Sarracenia* supply limiting nitrogen and phosphorus through prey capture in the insectivorous leaves.

THE USE OF NATIVE WETLAND PLANTS IN HIGHWAY LANDSCAPES. Philip M. Sheridan, Dept. of Biol., Virginia Commonwealth Univ., Richmond, VA 23284. The main function of highways is to transport goods and people from place to place. During the 1960's this concept was enlarged to include beautification. Today highways may also encompass biodiversity and be used as refuges and green corridors for native species. In 1983 I hypothesized that the addition of *Sarracenia*, *Drosera*, *Vaccinium* and *Calopogon* to an exit ramp sphagnum seepage community near Fredericksburg, Virginia would fulfill this role. All species have survived, flourished and spread and have received acclaim from both the state highway department and interested naturalists. Amending of similar sites in the coastal plain of Virginia may enhance the aesthetic aspects of our highways, educate the public to the value of under-utilized native species and serve as backup sites for propagated rare plant species.

PREDATORY IMPACT OF A WOLF SPIDER ON THE NORTHEASTERN BEACH TIGER BEETLE. Tammy Stockett and Barry Knisley, Dept. of Biol., Randolph-Macon Col., Ashland, VA 23005. Predation by the beach wolf spider, *Arctosa littoralis* on the Federally Threatened Northeastern beach tiger beetle, *Cicindela dorsalis dorsalis* was studied at Flag Ponds Nature Park, Calvert County, MD. Twelve night surveys (June through August) were conducted on alternate 50 meter sections of the 1500 meter shoreline to count numbers of spiders and beetles and to record all predation events by the spiders. Beetles and spiders commonly co-occurred on the beach from mid-June through August, with populations of both peaking in mid-July. Spiders were more abundant on the middle beach and least abundant on the north beach (a newly developed spit); beetles were most abundant on the south beach. Observed predation events by *A. littoralis* included 18 amphipods, 12 ants, 12 *C. dorsalis*, and 13 other arthropods during the 12 twice-nightly surveys. In laboratory feeding trials, spiders fed readily on crickets and beetles, but rarely on amphipods. We calculated an estimate (based on observed predation events and numbers of spiders and beetles active each night) of at least 500 adults of *C. d. dorsalis* eaten by spiders during the summer at this site.

HISTORICAL REVIEW AND DISTRIBUTIONAL STATUS OF CANEBRAKE RATTLE-SNAKE AND ITS HABITAT ON THE JAMES-YORK PENINSULA OF VIRGINIA. Robert A. S. Wright, Vanasse Hangen Brustlin, Inc., 7188 Chapman Drive, Hayes, VA. 23072.

Since February 1994, research has been undertaken to document the historical range for canebrake rattlesnake on the James-York Peninsula within portions of York County, and the Cities of Hampton and Newport News. Extant populations have been correctly identified as "in critical need of protection" in this region. The future for the canebrake, while "bleak", is not entirely without hope, according to my research. Utilizing some novel as well as standard investigative techniques, more than fifty new reports (photographs, skins, eyewitness accounts, public records etc.) document a more conclusive distributional range of sixty square miles on the Peninsula. The causes of habitat loss are quantified and discussed in this presentation; maps are shown to depict areas for future conservation efforts.

THE MEASUREMENT OF WATERFOWL DIVERSITY: A GUILD VERSUS A TAXONOMIC APPROACH. J. C. Wilgenbusch, Dept. of Biol., George Mason Univ., Fairfax, VA 22030. The relationship between species and guild diversity was examined for waterfowl utilizing a freshwater tidal embayment of the Potomac River in southern Fairfax County, Virginia. From 1985 to present, waterfowl at four transects were counted twice each Fall, Winter, Spring, and Summer. Birds were identified to species and assigned to one of six feeding guilds. Cumulatively, over 50,000 individuals birds were counted representing 29 genera and 47 species. Three species, two genera, and two guilds represent 56, 66, and 81 percent respectively of the total number of individual birds counted. The relationship between guild diversity and species diversity varied more seasonally than spatially. The number of species per guild dramatically increased due to seasonal migration, however each transect was differentially influenced by the seasonal influx. Although guild diversity and species diversity were highly correlated, as the number of species per guild increased the reliability of guild diversity as a surrogate for predicting species diversity decreased.

THE INFLUENCE OF WATER AVAILABILITY DURING INCUBATION OF *CHELYDRA SERPENTINA* ON POST-HATCHING GROWTH AND SURVIVORSHIP. J. C. Wilgenbusch, Dept. of Biol., George Mason Univ., Fairfax, VA 22030. The availability of water during incubation may have profound influences on the life history of reptiles with flexible shelled eggs. Other than the risk of lethal dehydration, *Chelydra serpentina* incubated on a dry substrate emerge from the egg significantly smaller than do hatchlings incubated on a wet substrate. Body size at hatching may influence the fitness of an individual either directly (differential survivorship) or indirectly (differential growth). The fitness consequences of variable body size due to the availability of water during incubation are dependent upon the magnitude and the persistence of the size differential caused by the availability of water during incubation. Wet and dry incubated *Chelydra serpentina* hatchlings were randomly assigned to a group or a solitary tank. Approximately 150 days after hatching, the average body size of dry and wet independently housed turtles coalesced. Survivorship among turtles housed in the group tanks was not related to incubation condition, rather survivorship was more closely related to clutch. These results indicate that the availability of water during incubation only temporarily influences the body size of independently housed hatchling *Chelydra serpentina* and that size differences due to the availability of water during incubation are less important than clutch related differences for survival in a group tank.

Psychology

AMERICAN VERSUS AFRICAN DIFFERENCES IN MATERNAL PERCEPTIONS OF CHILDRENS' PHYSICAL VERSUS EMOTIONAL WELL-BEING. R. Bhandari & J. Pickens, Department of Psychology, James Madison University, Harrisonburg, VA 22807. A survey assessed maternal perceptions of childrens' physical and emotional well-being, and was administered to 60 mothers in the United States and 55 mothers in Tanzania. Mothers in Tanzania rated physical factors about their children (nutrition, weight, height) as more important than emotional factors, compared with American mothers. The importance of play was rated similarly by mothers in both countries. Regression analysis showed that socio-economic status accounted for 9.3% of variation in physical well-being scores, 6.7% in temperament scores and 9.4% in mood scores. Significant differences in Tanzanian versus American mothers' rankings of emotional state, social interaction and physical activity of their child were observed. More American mothers ranked "emotional state of their child" as most important and "physical activity" as least important, compared with Tanzanian mothers who rated "physical activity" as most important and who tended to rate "social interactions" as least important. Future considerations for cross-cultural research on parenting were discussed.

VIOLENCE IN ROMANTIC RELATIONSHIPS. Jennifer Bonney & Barbara Winstead* Dept. of Psychology, Old Dominion Univ., Norfolk, Va. 23529. The study investigated verbal and physical violence in relationships. 212 participants. The Conflict Tactics Scale, Hendrick's Relationship Assessment Scale, Accommodation Scale were administered. Participants were classified into the Exit, Voice, Loyalty, or Neglect style of accommodation. Those classified as Exit reported higher levels of self-generated verbal abuse than the Neglect participants. The Never, Mild, and Moderate levels of self and partner-generated verbal and physical abuse were significantly related. No gender differences for self-generated verbal or physical abuse or partner-generated verbal abuse; however, females reported lower levels than males of partner-generated physical abuse. Higher levels of relationship satisfaction were significantly related to lower levels of partner-generated verbal abuse. Those classified as Voice or Loyalty reported higher levels of satisfaction than those classified as Exit.

EFFECTS OF PARENTING STRESS ON PARENT-CHILD INTERACTION QUALITY DURING THE MARSCHAK INTERACTION METHOD: A TASK ANALYSIS

S. Coffey and J. Pickens, Dept. of Psychology, James Madison Univ., Harrisonburg, VA 22807 This research investigated the effects of parenting stress on the interactions between parents and their children during the Marschak Interaction Method (MIM). During the MIM, parents are asked to perform a series of eight tasks with their children. This study examined interaction quality ratings on two individual MIM tasks - the "Parent Separation" task and the "Child Looks in the Mirror" task - and how behavior on these individual tasks were related to interaction quality ratings for the entire MIM. This study also assessed if interaction quality ratings differed between dyads where parents reported more versus less parenting stress on the Parental Stress Index (PSI). Coding schemes were developed to rate parent-child interaction behavior quality for the overall MIM and individual task performances. The results indicated that individual task ratings were positively correlated with ratings on the overall MIM. Dyads where the parent reported less parenting stress received more optimal ratings on each of the two tasks than dyads where the parent reported more parenting stress.

THE EFFECTS OF TARGET AGE, SUBJECT AGE, AND MEMORY TYPE ON ATTRIBUTIONS FOR MEMORY FAILURE. Michael Drew, Jennifer Harryn*, Jennifer Ziemba*, Kelly Spickard*, Jason Young*, and Jane M. Berry*, Dept. of Psychology, Univ. of Richmond, Richmond, VA 23173. This experiment investigated the influence of target age, subject age, and memory type (short-term, long-term, and very long-term) on attributions for other people's memory failures. 50 young (mean age= 20.64) and 49 old subjects (mean age= 70.71) read vignettes describing memory failures of old or young target persons. Subjects judged causes of failures by assigning percentage amounts to "lack of ability," "lack of effort," "task difficulty," and "other." MANOVA indicated that young subjects were significantly more likely to attribute failures to task difficulty and confirmed the double standard of failure attribution: Relative to failures of young targets, failures of old targets were more likely to be attributed to ability and less likely to be attributed to effort. As factor analysis indicated that memory type was not a salient attributional factor, results do not support Parr and Siegert's (1993) conclusion that the double standard is mediated by memory type.

THE ACT OF REQUESTING PERFORMANCE FEEDBACK: ADDITIONAL CONSIDERATIONS OF THE MOTIVATORS AND DETERRENTS. Bryan C. Hayes and Debra A. Major*, Dept of Psych, Old Dominion Univ., Norfolk, Va. 23529. The benefits of feedback have been established for many years with feedback considered essential to performance, adaptation to new environments, and is arguably one of the basic components of motivation. However, organizational members often perceive that they receive less performance feedback than is needed. Viewing feedback as a valuable resource to the individual, empirical evidence demonstrates that individuals do actively seek feedback and has linked this behavior to acquisition of knowledge and important outcomes to both the individual and organization. Several researchers have offered empirically supported models of the factors believed to determine when a person will and will not ask for performance feedback. Motivation to seek feedback comes from the benefits that the feedback information provides. However, certain situational factors (e.g., presence of third party observers) make overt request for feedback a risky act. These situational factors make certain behaviors appear risky and potentially damaging to impressions. This paper builds on existing models that predict when and how feedback seeking behavior (FSB) will take place. A model is developed that includes influence processes missing in the existing models.

THE EFFECT OF UNRECOGNIZED MEAN SUBGROUP DIFFERENCES ON CORRELATION COEFFICIENTS. C. Anthony Macera and Robert M. McIntyre, Dept. of Psych., Old Dominion Univ., Norfolk, VA 23529. During correlational studies, data are often pooled from two or more subgroups to increase the sample size of the predictor, the criterion, or both. When the predictor and/or criterion are treated as though they were composed of homogeneous subgroups, yet the subgroups actually contain mean differences, inaccurate conclusions can be made from the results. This paper addresses the problem as described by McIntyre (1990, *Jnl. Applied Psych.*, 75(1), 91-94), which explains how correlation coefficients can be obtained which are spuriously high or spuriously low when such differences are not taken into account. Here, original data from 6 previously conducted studies are reanalyzed to determine the differences in correlation coefficients obtained by using the Pearson r and by another formula which makes statistical adjustments for the mean differences across subgroups. No significant differences between the results of the 2 methods were found for the examined studies. It is expected that such differences will appear as more studies are reanalyzed.

EFFECT OF LESIONS OF THE AREA POSTREMA ON INGESTIVE BEHAVIORS AND REPRODUCTIVE ACTIVITY OF GROWTH-RESTRICTED PREPUBERTAL FEMALE RATS. J.A. Olejniczak, H. l'Anson and L.E. Jarrard, Depts. of Biology and Psychology, Washington and Lee University, Lexington, VA 24450. Lesions of the area postrema (AP), a circumventricular organ located on the dorsal surface of the medulla, cause hypophagia and body weight loss in adult rats. The AP also appears to detect brain glucose availability and has been implicated in the metabolic regulation of estrous cyclicity. We investigated the effects of the AP lesion on ingestive behavior and onset of puberty in food restricted female rats with delayed puberty. Female rats ($n=12$) were placed on a restricted diet to maintain a weight of 80-90 g. On day 54-55 of age, the AP was lesioned using gentle aspiration ($n=5$) or sham lesioned ($n=7$). Sham and AP lesioned rats showed a similar pattern of body weight changes following surgery. AP lesioned rats consumed more water (AP: 17.0 ± 3.1 ml/day; SHAM: 9.7 ± 0.2 ml/day) compared to Sham lesioned rats, but did not require more food to maintain their pre-lesion body weight. All rats remained acyclic. These results suggest that the AP may play a role in controlling ingestive behavior in the rat, but may not be the only CNS structure which is important in this regard. In addition, since these growth-restricted rats did not begin cycling following AP-lesion, these results do not support the hypothesis that the AP provides an inhibitory signal to reproductive activity during times of decreased food availability. (Supported by NIH HD-07433).

EFFECTS OF CLOTHING ON PERCEPTIONS OF SOCIAL POWER: ADDING A JACKET TO A SKIRT-AND-BLOUSE. W. Bryan Pennington, Jr., Laurie L. Kerr, Christine E. Nelms, Rachel L. Hoaglund, and James P. O'Brien, Social Sciences Div., Tidewater Cmnty. Col., Virginia Beach VA 23456. Temple & Loewen (1993) found that subjects, asked to imagine a "large office complex" setting, rated faceless line-drawings of a woman dressed in a jacket higher in total, expert, and legitimate power than those without a jacket on an expanded version of the Attributed Power Index (API). This modified replication presented 6 classes of community colleges students with an actual woman dressed in a skirt-and-blouse (NJ; n=56) or with a jacket and skirt-and-blouse (J; n=57). All subjects were asked to line up in order of birth-month and -day, without speaking, and to complete the API; errors were also recorded. With $df=111$, t-tests were not statistically significant for total score or any of the five API scales for types of social power. Compliance analyses are unavailable at this time. Whether Temple & Loewen's results apply to real situations, including the "large office complex" imagined by their subjects, is unresolved.

TEACHER'S AND CHILDREN'S RESPONSES TO COMPUTER ASSISTED INSTRUCTION J. Pickens and C. Wallack*, Dept. of Psychology, James Madison Univ., Harrisonburg, VA 22807. College students preparing for careers as teachers in early childhood and secondary education participated in a course on Computer Assisted Instruction (CAI) at James Madison University. Twenty-four student-teachers practiced using 12 different educational software products. These student-teachers then instructed 62 children (ranging in age 3 to 11 years) in the use of these educational programs and observed them. The student-teachers generally rated CAI as enjoyed by children, more engaging than text-books, and developmentally appropriate for a wide range of students. Differences were noted across CAI programs in the difficulty children had learning the rules of the games and in learning to use the keyboard or mouse to play these educational games. For over 200 evaluations completed on 12 software products, student-teachers reported significant differences across programs in ease of use, flexibility, pacing, the reinforcing quality of graphics and sounds, and whether they would use the CAI products in their own classrooms. These results suggest that future educators rate CAI positively, but that training is necessary for educators to effectively differentiate and select products and then incorporate CAI in their classrooms.

THE ROLE OF IMAGE GENERATION ON THE RECOLLECTION OF THE SERIAL ORDER OF ODORS. Suzanne M. Sharp, Allison Foote*, & David G. Elmes, Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450-0303. The effects of odor imagery on the memory for common odors was examined in two experiments. In the first experiment, the subjects either sniffed a substance, imagined the visual characteristics of it, or imagined its odor. After a filler task, old/new recognition was tested for either the target odor or the name of the odor. Source recognition was also assessed by having subjects indicate the encoding condition for the items labeled old. Odor imagery did not enhance the hit rate or the source recognition. In the second experiment, some subjects generated a context for several odors, while yoked subjects received the generated descriptions. Half of all subjects expected a memory test, and the remainder did not. Serial order recognition was tested twice with a week between tests. Retention fell during the test interval, but it was not influenced by either generation or knowledge of the upcoming test. The present data agree with earlier results that seem to indicate that odor memory is not strongly influenced by top-down processing.

ACQUISITION OF A CONCURRENT OLFACTORY DISCRIMINATION TASK IN RATS: EFFECTS OF ENTORHINAL CORTEX LESIONS. E. W. Smith, C. M. Sturge, S. Dall'Vechia, and L. E. Jarrard, Dept. of Psychol., Washington & Lee Univ., Lexington, VA. 24450. Our previous research has shown that rats are able to learn a complex, 8-pair, concurrent, olfactory discrimination task. Pairs of olfactory stimuli (e.g., oregano vs. cumin) are repeatedly presented where one odor in each pair is consistently reinforced. It is well known that the entorhinal cortex receives direct projections from the olfactory bulb, and it has been reported that this structure plays an important role in the processing of olfactory stimuli. In the research to be reported the entorhinal cortex was removed selectively, and the rats were trained on the concurrent, olfactory discrimination task. The results indicated that rats with the entorhinal cortex removed learned the complex task at the same rate as controls. These results will be discussed as they relate to previous research and the reports that the entorhinal cortex plays a vital role in the processing and storage of olfactory information.

ATTACHMENT STYLES AND JEALOUSY IN ROMANTIC RELATIONSHIPS. Melinda Swager and Barbara Winstead*, Dept. of Psych., Old Dominion Univ., Norfolk, VA 23529. This study analyzed the relationship between attachment styles and romantic jealousy in adult romantic relationships. Undergraduates completed a series of questions concerning their feelings in their present or past romantic relationships. Students reported one of three attachment styles: secure, avoidant, or anxious-ambivalent. Romantic jealousy was assessed using the Interpersonal Jealousy Scale. In addition, this study differentiated between emotional and sexual jealousy. As predicted, anxious-ambivalents reported higher levels of jealousy than secures. However, avoidants did not differ significantly from the other two styles in their level of jealousy. Males reported feelings of sexual jealousy more often than females; females reported feelings of emotional jealousy more often than males. However, no relationship was found among attachment styles and type of jealousy. Results of this study point to the need for further research distinguishing between the emotional and sexual aspects of jealousy.

THE ROLE OF INTENTION IN LEARNING: AN EEG ANALYSIS. Nicholas Tatar, Julie Ann Olejniczak, Margaret Randol*, Robert Taylor*, David G. Elmes, Dept. of Psychology, Washington and Lee University, Lexington, VA 24450-0303, and Thomas P. Urbach, Department of Philosophy, SUNY Binghamton, Binghamton, NY 13902-6000. While ERPs to individual words were being collected, three different groups of subjects studied 120 five-letter words that were presented amidst two filler tasks. The test for retention was a stem completion task, in which stems of the 120 targets and some fillers were presented and the subjects were supposed to complete them. The Inclusion Group was not given memory instructions and was told to complete the stems with the first word that came to mind. The Exclusion Group was not given memory instructions and was told to complete the stem with the first word that came to mind that had not been used in a previous phase of the experiment. The Explicit Group was told about the memory test and was told to use previous words to complete the stems. Most stems were completed by the Explicit Group and fewest by the Exclusion Group. Peak positive ERPs during the test phase occurred between 400 and 600 ms post stimulus. For correct stem completions, the peak ERPs for the Exclusion Group tended to be greater in the right hemisphere than those for the Explicit Group. We have tentative evidence for different neuronal generators for implicit and explicit memory.

ON THE ROLE OF THE HIPPOCAMPUS IN CUED AND CONTEXTUAL APPETITIVE CONDITIONING. T. S. Trigilio, B. Bowring, L. E. Jarrard and T. L. Davidson. Dept. of Psychology, Washington and Lee Univ., Lexington, VA 24450, and Dept. of Psychology, Purdue Univ., Lafayette, IN. Rats were trained in an appetitive classical conditioning task where a tone conditioned stimulus (CS) was followed by a unconditioned stimulus (US) (food). Half of the animals received 3 unsignalled USs and half 0 unsignalled USs. After 15 days of training where activity before and during the CS and before the US in unsignalled trials was recorded, half of the rats in each group had the hippocampus removed and half served as controls. Postsurgery, the rats underwent 14 days of extinction where no food US's were given. The results showed that rats with hippocampal lesions were slower to extinguish the response to the CS but there were no differences between groups in activity that preceded the unsignalled US's. The results indicate that removing the hippocampus impairs the rats' ability to learn inhibition to cues that have undergone both excitatory and inhibitory training.

INFORMATION SEEKING AND ATTRIBUTIONS: PERCEIVED COSTS VERSUS ACTUAL COSTS. Jonathan E. Turner, Bryan C. Hayes, and Debra A. Major, Dept. of Psych., Old Dominion Univ., Norfolk, VA. 23529. The effects of information seeking in the workplace on attributions made about the seeker were investigated using a hypothetical scenario where an individual sought specific types of information from the subject. One hundred sixteen subjects, 29 of which had supervisory experience, responded to a questionnaire assessing perceived organizational commitment of the seeker, use of ingratiation tactics, the seeker's self-interest, ability, organizational potential and allocation of rewards, and the degree to which they would help the seeker. The seeker's characteristics varied by tenure, relative position to the subject, and the type of information being sought. It was found that supervisors perceived the seeker to be more committed and deserving of greater rewards when technical as compared to feedback information was sought. When subjects assumed the role of the seeker's coworker, they perceived the seeker to be more committed and deserving of rewards when feedback information was sought. Main effects for information type sought and tenure were found for ingratiation /rewards and self-interest respectively.

THE EFFECT OF STUDENT-PAID PORTION OF COLLEGE EXPENSES ON ACADEMIC ACHIEVEMENT AND PERSISTENCE AMONG COMMUNITY COLLEGE STUDENTS. Doris M. Velazquez, Debra L. Vendt, Maria E. Marscheider, Linda E. Miller¹, and James P. O'Brien, Social Sciences Div., Tidewater Cmnty. Col., Virginia Beach VA 23456 (and ¹SUNY, Old Westbury). Personal contacts with leaders in the field revealed that students' personal financial burden (SB) was considered (1) important, (2) extremely complex, (3) difficult to measure, (4) absent from the research literature, and (5) qualitative measures were recommended. Trials of the qualitative survey indicated that military and veterans (MV) students presented unique problems and a second version for these students was developed (MV data was not analyzed here). It was hypothesized that SB would be positively related to GPA and negatively related to Persistence (P) for community college students (N=79). As existing literature does support, r's were significant for the Parental Non-Support measure x GPA, $r = +.397$, and x P, $r = -.308$, beyond .0005 and .005 levels of significance (1-tailed tests), respectively. More direct SB measures, however, must be rescored since the ranking devices used in these analyses appear to be too coarse, although some reached significance beyond the .05 level. This study apparently represents the first reported treatment of the effects of student-paid vs. parent-paid portions of college costs.

THE RELATIONSHIP BETWEEN PERCEIVED STRESS AND COPING STYLE. Adria N. Villarreal & Elaine M. Justice*, Dept. of Psych., Old Dominion Univ., Norfolk Va. 23508. Traditional and non-traditional aged students completed the Hassles & Uplifts State Scale as an indication of perceived stress. Coping style was also assessed. Results indicated that traditional-aged students reported a greater frequency, higher cumulated severity, and higher average intensity of both hassles and uplifts than non-traditional aged students. Individuals with a problem-solving coping style differed from those with social support and emotion-focused coping styles. Problem-solvers reported a significantly higher frequency and cumulated severity of both hassles and uplifts. Thus, both age and coping style affected perceived stress.

Statistics

AN OUTLIER RESISTANT REGRESSION METHOD IN THE PRESENCE OF MODEL MISSPECIFICATION. Christopher A. Assaid & Jeffrey B. Birch, Dept. of Statistics, VPI&SU, Blacksburg, VA 24061. Parametric regression fitting (such as OLS) to a data set requires specification of an underlying model. If the specified model is different from the true model, then the parametric fit suffers to a degree that varies with the extent of model misspecification. Mays and Birch (1995) addressed this problem in the one regressor variable case with a method known as Model Robust Regression (MRR), which is a combination of parametric and nonparametric techniques. This paper was based on the underlying assumption of "well-behaved" (Normal) data. The method seeks to take advantage of the beneficial aspects of the both techniques: the parametric, which makes use of the prior knowledge of the researcher via a specified model, and the nonparametric, which is not restricted by a (possibly misspecified) underlying model.

The method introduced here (termed Outlier Resistant Model Robust Regression (ORMRR)) addresses the situation that arises when one cannot assume well-behaved data that vary according to a Normal distribution. RMRR is a blend of a robust parametric fit, such as M-estimation, with a robust nonparametric fit, such as LOWESS. Some properties of the method will be discussed as well as illustrated with an example.

A SURVIVAL ANALYSIS OF A PROSPECTIVE STUDY COMPARING A NEW PROCEDURE TO THE STANDARD PROCEDURE FOR VARICEAL BLEEDING. Wendy B. London, Dept. of Biostatistics, Medical College of Virginia at Virginia Commonwealth University, Box 32, Richmond, Va. 23298-0032. An application of a Cox proportional hazards model was used to perform a survival analysis. The objective of this analysis was to determine whether or not there was a difference between the survival rates of patients who received the "standard" procedure versus those who received a "new" procedure for bleeding gastrointestinal varices. The analysis also determined the extent to which risk factors affected the survival rates. Two models were developed: Model A included all clinically important risk factors as identified by the clinician, while Model B included only statistically significant variables and was used to make predictions about survival rates. When tested, all time-dependent covariates were found to be not significant; therefore, proportional hazards existed. A sensitivity analysis was performed to check for potential bias introduced by informative censoring. A statistically significant difference between the two procedures was detected, and statements were made regarding the significant risk factors.

A MODEL ROBUST DUAL MODELING APPROACH TO HETEROGENEITY OF VARIANCE IN A REGRESSION SETTING. Tim Robinson & Jeffrey B. Birch, Dept. of Statistics, VPI&SU, Blacksburg, VA 24061. In typical normal theory regression, the assumption of homogeneity of variances is often not appropriate. Instead of treating the variances as a nuisance and transforming away the heterogeneity, the structure of the variances may be of interest and it is desirable to model the variances. Aitkin (1987) proposes a dual model in which a log linear dependence of the variances on a set of explanatory variables is assumed. Aitkin's approach is an iterative one providing estimates for the parameters in the mean and variance models through joint maximum likelihood. Estimation of the mean and variance parameters are interrelated as the responses in the variance model are the squared residuals from the fit to the means model. Our research will consider the impact of model misspecification in one or both of the models in Aitkin's dual model approach. Mays and Birch (1995) have demonstrated an effective semi-parametric method to situations of model misspecification in the one regressor setting. Using their techniques, we develop a dual model similar to Aitkin's but which is robust to misspecification in either or both of the two models. For instance, if the means model is misspecified, we show that the squared residuals from the model robust fit of Mays and Birch is more appropriate for the response data in the variance model than squared residuals from a misspecified parametric model. Examples will be presented to illustrate the new technique, termed here as Dual Model Robust Regression.

VIRGINIA JUNIOR ACADEMY OF SCIENCE AWARDS 1996 ANNUAL MEETING

AGRICULTURAL AND ANIMAL SCIENCE

Honorable Mention:	Sherwood T. Green, Jr.	Gloucester High School
Honorable Mention:	Marisela Rodriguez	Matoaca High School
Honorable Mention:	Russell G. Yates	Gloucester High School
Third Place:	Adrianna N. Hancock	Atlee High School
Second Place:	Kara M. Doggett	Isle of Wight Academy
First Place:	Brian M. Green	Yorktown High School

ANIMAL BEHAVIOR (ETHOLOGY)

Honorable Mention:	Heather B. Green	Yorktown High School
Honorable Mention:	Nadia E. Hilliard	Tuckahoe Middle School
Honorable Mention:	Michael J. Smith	Thomas Jefferson Middle School
Third Place:	Jessica A. Costa	Gloucester High School
Second Place:	Aaron L. Kelly	Gloucester High School
First Place:	Pascal R. Deboeck	Bishop O'Connell High School

BOTANY 'A'

Honorable Mention:	Lindsay D. Austin	Atlee High School
Honorable Mention:	Amanda G. Bock	Menchville High School
Honorable Mention:	Brandt R. Carr	Tuckahoe Middle School
Third Place:	A. Meaghan Anderson	Patrick Henry High School
Second Place:	Angela M. Concepcion	Bishop O'Connell High School
First Place:	Jean M. Bower	Central Virginia Governor's Sch.

BOTANY 'B'

Honorable Mention:	Irena R. Hollowell	Yorktown High School
Honorable Mention:	K. Elizabeth Magalis	Midlothian High School
Honorable Mention:	Veronica H. Moreno	Thomas Jefferson Middle School
Third Place:	Meredith Meyer	Washington-Lee High School
Second Place:	Bonmyong Lee	Washington-Lee High School
First Place:	Paula R. Katz	Roanoke Valley Governor's Sch.

BOTANY 'C'

Honorable Mention:	Kevin J. Will	H.B. Woodlawn
Honorable Mention:	Devin C. Woods	Richmond Community High Sch.
Honorable Mention:	Mary D. Wortham	Atlee High School
Third Place :	Janice E. Pour	Atlee High School
Second Place:	Julie A. Plagenhoef	Cave Spring High School
First Place:	Jessicah S. Phillips	Central Virginia Governor's Sch.

CHEMISTRY 'A'

Honorable Mention:	Dominique B. Caovan	Bishop O'Connell High School
Honorable Mention:	Mark H. Dreusicke	Midlothian High School
Honorable Mention:	Ann B. Hanes	Patrick Henry High School
Third Place:	Kimberly M. Greer	Fieldale-Collinsville High Sch.
Second Place:	Molly C. Cahill	Swanson Middle School
First Place:	Torrey B. Dunbar	Southwest Virginia Governor's School

CHEMISTRY 'B'

Honorable Mention:	Jeremy G. Larochelle	Bishop O'Connell High School
Honorable Mention:	Mindy L. McCord	Liberty Middle School
Honorable Mention:	Emily K. Moxley	Tuckahoe Middle School
Third Place:	Brian M. Newman	Southwest Virginia Governor's School
Second Place:	Eileen S. Krenzel	Kecoughtan High School
First Place:	Curtis J. Layton	Cave Spring High School

CHEMISTRY 'C'

Honorable Mention:	Meredith C. Spivey	Isle of Wight Academy
Honorable Mention:	Steven E. Wheeler	Clover Hill High School
Third Place:	Meghan S. Skinner	Tuckahoe Middle School
Second Place:	Maria R. Sonevytsky	Yorktown High School
First Place:	Pradeep Rajan	Governor's School for Government and International Studies

COMPUTER SCIENCE

Honorable Mention:	Laura J. Black	Yorktown High School
Third Place:	Shishir S. Mehrotra	New Horizons Governor's Sch.
Second Place:	Johann M. Schleier-Smith	Thomas Jefferson High School for Science and Technology
First Place:	Liem T. Ha	Wakefield High School

CONSUMER SCIENCE 'A'

Honorable Mention:	Ryan E. Billingsley	Cave Spring High School
Honorable Mention:	Sarah E. Brown	Williamsburg Middle School
Honorable Mention :	Caroline L. Burnet	Ferguson High School
Third Place:	Lisa M. Coward	Lloyd C. Bird High School
Second Place:	Meredith A. Bailey	Douglas Freeman High School
First Place:	Brad W. Butcher	Menchville High School

CONSUMER SCIENCE 'B'

Honorable Mention:	Christie E. Gaskins	Harry F. Byrd Middle School
Honorable Mention:	Peyton C. Gouldin	Stonewall Jackson Middle School
Honorable Mention:	Sarah E. Johnson	Hines Middle School
Third Place:	Justin A. Gayle	Chickahominy Middle School
Second Place:	Kris T. Huang	Midlothian High School
First Place:	John M. Fout	Clover Hill High School

CONSUMER SCIENCE 'C'

Honorable Mention:	Laura A. Kalichak	Clover Hill High School
Honorable Mention:	Ashley J. Kirkham	Chickahominy Middle School
Honorable Mention:	Justin D. Morgan	Roanoke Valley Governor's Sch.
Third Place:	Jennifer E. Miller	Gloucester High School
Second Place:	Jay J. Mizack	Cave Spring High School
First Place:	Jaime L. Moore	Atlee High School

ENGINEERING 'A'

Honorable Mention:	Jonathan S. Cheek	Williamsburg Middle School
Honorable Mention:	Christopher W. Genheimer	Patrick Henry High School
Honorable Mention:	Brad R. Gunton	Clover Hill High School
Third Place:	Benjamin S. Draper	Hermitage High School
Second Place:	Jason N. Daugherty	Gloucester High School
First Place:	Clinton M. Davis	Clover Hill High School

ENGINEERING 'B'

Honorable Mention	Joseph A. Moore	Liberty Middle School
Honorable Mention:	Christopher D. Ryan	Gildersleeve Middle School
Honorable Mention:	Kevin P. Wegener	Thomas Jefferson High School for Science and Technology
Third Place:	Emmeline N. Weber	Central Virginia Governor's Sch.
Second Place:	Kartik G. Srinivas	Thomas Jefferson High School for Science and Technology
First Place	James D. Ohl	Central Virginia Governor's Sch.

ENVIRONMENTAL SCIENCE 'A'

Honorable Mention:	Lori E. Aitkenhead	Gildersleeve Middle School
Honorable Mention:	Emily K. Clarke	Bishop O'Connell High School
Honorable Mention :	Annie T. Eure	Roanoke Valley Governor's Sch.
Third Place:	Caroline L. Burnet	Ferguson High School
Second Place:	Matthew G. Eddy	Thomas Jefferson Middle School
Second Place:	Jennifer B. Ambler	First Colonial High School
First Place:	David A. Bray	T.C. Williams High School

ENVIRONMENTAL SCIENCE 'B'

Honorable Mention:	Rangina Hamidi	Wakefield High School
Honorable Mention:	Carrie D. Jennings	Central Virginia Governor's Sch.
Honorable Mention:	Mary-Ellen W. Lahy	Tuckahoe Middle School
Third Place:	Abigail R. Ferrance	Roanoke Valley Governor's Sch.
Second Place:	Winston Gwathmey	Norfolk Academy
First Place:	Kristy A. Jones	Patrick Henry High School

ENVIRONMENTAL SCIENCE 'C'

Honorable Mention:	Stephen M. Ng	Yorktown High School
Honorable Mention:	Beth G. Oesterling	Gloucester High School
Honorable Mention:	Crystal C. Peery	Central Virginia Governor's Sch.
Third Place:	Rebecca C. Oser	Yorktown High School
Second Place:	Diameng Pa	Wakefield High School
First Place :	Katherine E. Randle	Williamsburg Middle School

ENVIRONMENTAL SCIENCE 'D'

Honorable Mention:	Alan M. Trammell	Lloyd C. Bird High School
Honorable Mention:	Sheila M. Urie	Central Virginia Governor's Sch.
Honorable Mention:	Chris Yurek	Gunston Middle School
Third Place:	Sarah M. Smith	Yorktown High School
Second Place:	Clay L. Sellers	Broadway High School
First Place:	Katherin M. Slimak	West Springfield High School

GENETICS AND CELLULAR BIOLOGY

Honorable Mention:	Sarah T. Wilkinson	Patrick Henry High School
Third Place:	Matthew B. Potts	Thomas Jefferson High School for Science and Technology
Second Place:	Jesse K. Liu	Thomas Jefferson High School for Science and Technology
First Place:	Jessica D. Kessler	Mills E. Godwin High School

MATHEMATICS AND STATISTICS 'A'

Honorable Mention:	Bo Fisher	Woodberry Forest School
Honorable Mention:	Jonathan L. Jesneck	Woodberry Forest School
Honorable Mention:	William S. Knight	Woodberry Forest School
Third Place:	William H. Higgins	Woodberry Forest School.
Second Place:	Jacob G. Foster	Woodberry Forest School
First Place:	Loren K. Hoffman	Governor's School for Govern- ment and International Studies

MATHEMATICS AND STATISTICS 'B'

Honorable Mention:	Chris M. Recht	Woodberry Forest School
Honorable Mention:	Jason A. Ross	Menchville High School
Honorable Mention:	Shaun K. Smith	Woodberry Forest School
Third place:	Milan M. Patel	Woodberry Forest School
Second Place:	Jennifer K. Murrill	Atlee High School
First Place:	Greg Y. Tseng	Thomas Jefferson High School for Science and Technology

MEDICINE AND HEALTH 'A'

Honorable Mention:	Lisa B. Boyette	Gloucester High School
Honorable Mention:	Karen E. Bruner	Lloyd C. Bird High School
Honorable Mention:	Samantha B. Debicki	Williamsburg Middle School
Third Place:	Heather S. Johnson	Yorktown High School
Second Place :	Paul L. Gross	Cave Spring High School
First Place:	Tom L. Harmon	Atlee High School

MEDICINE AND HEALTH 'B'

Honorable Mention:	Shelly D. Layser	Gildersleeve Middle School
Honorable Mention:	Nisha Nagarkatti	Blacksburg Middle School
Honorable Mention:	Thao-ly T. Phan	Manchester Middle School
Third place:	Catherine R. Lewis	Mills E. Godwin High School
Second Place:	Alexa J. Merchant	Mills E. Godwin High School
First Place:	Rahul Kapur	Thomas Jefferson High School for Science and Technology

MEDICINE AND HEALTH 'C'

Honorable Mention:	Stepahnie C. Stauffer	Washington-Lee High School
Honorable Mention:	Sidney J. Traynham	Thomas Jefferson Middle School
Honorable Mention:	Melissa B. Weimer	Atlee High School
Third Place:	Taharee A. Webb	Roanoke Valley Governor's Sch.
Second Place:	Shobha C. Ranganath	Governor's School for Govern- mentand International Studies
First Place:	Malika I. Seth	Thomas Jefferson High School for Science and Technology

MICROBIOLOGY 'A'

Honorable Mention:	George E. Ashton	Governor's School for Govern- ment and International Studies
Honorable Mention:	Susan E. Cocker	Yorktown High School
Honorable Mention:	Amanda J. Harpold	Cave Spring High School
Third Place:	Alex C. Herzick	Gloucester High School
Second Place:	Stephen R. Collins	Southwest Virginia Governor's School
First Place:	Matthew S. Emery	Clover Hill High School

MICROBIOLOGY 'B'

Honorable Mention:	Elizabeth F. Huff	Tuckahoe Middle School
Honorable Mention:	Jennifer M. Jordan	Gloucester High School
Honorable Mention:	Thomas U. Marron	H.B. Woodlawn
Third Place:	Alexander L. Miller	Peasley Middle School
Second Place:	Dorian J. Zoumplis	Warwick High School
First Place:	Rebecca A. Yurek	Wakefield High School

MULTIPLE AUTHORED PAPERS

Honorable Mention:	David M. Kertesz	
	Daniel M. Kertesz	Kecoughtan High School
Honorable Mention:	David H. Logan	
	Faisal S. Malik	Yorktown High School
Honorable Mention :	Kimberly N. Woodlen	
	Kasey S. Wilson	
	Shanika A. Armstead	Peasley Middle School
Third Place:	Joanna L. Gayle	
	Laura R. Wherry	Atlee High School
Second Place:	Erika Y. Cook	
	Rasmi P. Chhang	
	Sara B. Robinson	Wakefield High School
First Place	Erik M. Wishneff	
	Tracy A. D'Souza	
	Joy L. Monar	Roanoke Valley Governor's Sch.

PHYSICS 'A'

Honorable Mention:	Erin B. Chisom	Ferguson High School
Honorable Mention:	Dylan S. Fugate	Richmond Community High Sch.
Honorable Mention:	Jessica Garrison	Gunston Middle School
Third Place:	Gregory C. Brown	Thomas Jefferson Middle School
Second Place:	John P. Dulka	Yorktown High School
First Place:	Amanda S. Bowser	Menchville High School

PHYSICS 'B'

Honorable Mention:	Benjamin Z. Grossberg	Tuckahoe Middle School
Honorable Mention:	Hoon P. Joo	Yorktown High School
Honorable Mention:	Jonathan Kurshan	Roanoke Valley Governor's Sch.
Third Place :	Daniel J. Hettich	Wakefield High School
Second Place:	Czer A.E. Lim	Tallwood High School
First Place:	Jakob B. Harmon	Chickahominy Middle School

PHYSICS 'C'

Honorable Mention:	Victor Q. Nguyen-long	Yorktown High School
Honorable Mention:	Tracy D. Raciborski	B.T. Washington Middle School
Honorable Mention:	Joseph D. Schwartz	Bishop O'Connell High School
Third Place:	David S. Radloff	Turner Ashby High School
Second Place:	Kevin L. Setter	H.B. Woodlawn
First Place:	Van F. Smith	Central Virginia Governor's Sch.

PSYCHOLOGY - GENERAL

Honorable Mention:	Catherine Chan	Yorktown High School
Honorable Mention:	M. Martin Kessler	William Byrd High School
Honorable Mention:	Thomas C. Westmoreland, Jr.	Southwest Virginia Governor's School
Third Place:	Jeffrey D. Chadwick	Tuckahoe Middle School
Second Place:	Adam S. Bronstein	Yorktown High School
First Place:	Daniel C. Moss	Yorktown High School

PSYCHOLOGY - LEARNING & PERCEPTION 'A'

Honorable mention:	Emily K. Anthes	Williamsburg Middle School
Honorable mention:	Alison M. Berry	The New Community School
Honorable mention:	Vernon J. Hurte	Richmond Community High Sch.
Third Place:	Lisa A. Fletcher	Lloyd C. Bird High School
Second Place:	Lloyd F. Coley	Woodberry Forest School
First Place:	Jonathan V. Davidow	Tuckahoe Middle School

PSYCHOLOGY - LEARNING & PERCEPTION 'B'

Honorable Mention:	Kristen M. Moolhuizen	Atlee High School
Honorable Mention:	Ashley H. Snyder	St. Anne's Belfield School
Third Place:	Sarah B. Shapiro	Tuckahoe Middle School
Second Place:	Zachary A. Schendel	Clover Hill High School
First Place:	Sara N. Tsuchitani	Yorktown High School

PSYCHOLOGY - SOCIAL

Honorable Mention:	Erin B. Ashwell	Roanoke Valley Governor's Sch.
Honorable Mention:	Leslie B. Dubeck	Williamsburg Middle School
Honorable Mention:	Erin J. Wamsley	Wakefield High School
Third Place :	Allison L. Elias	Roanoke Valley Governor's Sch.
Second Place:	Kendra P. Robins	Norfolk Academy
First Place:	Patrica A. Niermeyer	J.R. Tucker High School

ZOOLOGY 'A'

Honorable Mention:	David P. Andrukonis	Williamsburg Middle School
Honorable Mention:	Bernice E. Boden	Yorktown High School
Honorable Mention:	Hailey A. Elliott	Warwick High School
Honorable Mention:	Heather R. Hornick	Clover Hill High School
Third Place:	Anita A. Bachlani	Chickahominy Middle School
Second Place:	Virginia R. Ebbett	Roanoke Valley Governor's Sch.
First Place:	Sarah M. Barden	Clover Hill High School

ZOOLOGY 'B'

Honorable Mention:	Brittany L. Hott	Patrick Henry High School
Honorable Mention:	Elaine M. Pour	Chickahominy Middle School
Honorable Mention:	Larry W. Snyder, Jr.	Atlee High School
Third Place:	Reed A. Kitchen	Tuckahoe Middle School
Second place:	Candice B. Smith	Yorktown High School
First Place:	Matthew W. King	Gloucester High School

SPECIAL AWARDS

Botany Section Award, given by the Botany Section of the VAS, to the best paper On a botanical subject.

Paula R. Katz
Roanoke Valley Governor's School

VJAS Neuroscience Awards supported by the Auxiliary of the Virginia Neurological Society are given to three outstanding papers in the field of neuroscience.

Emily Clark
Bishop O'Connell High School

Jennifer Jordan
Gloucester High School

Alexa Merchant
Mills E. Godwin High School

Speleological Society Award given to the best paper addressing karst or topics related to speleology given by the Richmond Area speleological society.

Thu B. Le
Meadowbrook High School

Mathematics Award for the paper that evidences the most significant contribution in the field of Mathematics.

Greg Y. Tseng
Thomas Jefferson High School for Science and Technology

Smith Shadomy Infectious Disease Award in honor and memory of Dr. Smith Shadomy given by the Virginia Chapter of the National Foundation of Infectious Diseases.

Justin C. Meadows
Patrick Henry High School

Roscoe Hughes Award for the best paper in the field of Genetics.

Jessica D. Kessler
Mills E. Godwin High School

Rodney C. Berry Chemistry Award for the paper that evidences the most significant contribution in the field of chemistry.

Curtis J. Layton
Cave Spring High School

The Dr. and Mrs. Preston H. Leake Award in Applied Chemistry will be given to the author of a research paper which best exemplifies how chemicals, chemical principles, or chemistry have been used, are used, or might be used to enhance or even to save life.

Jessica D. Kessler
Mills E. Godwin High School

Russell J. Rowlett Award for the Best Research Paper of the Year.

Rahul Kapur
Thomas Jefferson High School for Science and Technology

The Virginia Psychological Foundation Meritorious Research Awards recognize outstanding presentations of research in the various fields of psychology.

Daniel C. Moss
Yorktown High School

Jonathan V. Davidow
Tuckahoe Middle School

Sara N. Tsuchitani
Yorktown High School

Patricia A. Niermeyer
J.R. Tucker High School

Virginia Sea Grant College Program Award is given by the Virginia Sea Grant College Program for outstanding marine or coastal research.

Heather M. Smith
Gloucester High School

American Cancer Society Award - This award is to recognize outstanding science papers related to cancer research. These awards are provided by the American Cancer Society (Virginia Division), Public Education Committee.

Honorable Mention
Catherine R. Lewis
Mills E. Godwin High School

Third Place
Jessica D. Kessler
Mills E. Godwin High School

Second Place
Brad Butcher
Menchville High School

First Place
Tom L. Harmon
Atlee High School

The Gamma Sigma Delta Award (Agriculture). Presented by the VPI & SU Chapter of the Honor Society of Agriculture. This award is presented in recognition of excellence in research dealing with application of new technologies and/or concepts in agriculture forestry, or veterinary medicine.

BRIAN M. GREEN
Yorktown High School

W. W. Berry Award.-This award is given by VA Power in honor of Mr. W. W. Berry who was a past Chairman of the Board of VA Power. This award of a Savings Bond will be presented to the best engineering paper.

JAMES D. OHL
Central Virginia Governor's School

The Joyce K. Peterson Award is presented for the outstanding paper by a middle school student. It is presented in honor of Mrs. Joyce K. Peterson who has been an outstanding teacher in the Arlington County Schools.

Kristen Altman
Chickahominy Middle School

Trip to AJAS - AAAS Meeting for two students and two alternates for presenting outstanding papers. the 1997 meeting will be held in February in Seattle, Wa

Winner:	Van F. Smith	Central Virginia Governor's Sch.
Winner:	Jessial D. Kessler	Mills E. Godwin High School
alternate:	Curtis J. Layton	Cave Spring High School
alternate:	Greg Y. Tseng	Thomas Jefferson High School for Science and Technology

Honorary Membership - AAAS given to two students.

CLAY SELLERS
Broadway High School

MEREDITH BAILEY
Douglas Freeman High School

Honorary Membership - VAS

DIAMENG PA
Wakefield High School

Bethel High School Scholarship - This \$1,000 Scholarship Award comes from the interest earned from a \$10,000 endowment contributed by the students of Bethel High School, Hampton, Va., over a two year period. Accompanying this scholarship is a rotating plaque to be displayed in the student's school for the next year. This award is based on both the students presentation and paper.

KATHERIN M. SLIMAK
West Springfield High School

Frances and Sydney Lewis Environmental Scholarship: A \$14,000 scholarship (\$3,250 per year for four years) for the best effort by a student grades 9 to 12 in the field of environmental science. This scholarship is in the name of Frances and Sydney Lewis and is given by the Virginia Environmental Endowment.

BRIAN M.GREEN
Yorktown High School

VAS Science Teacher Award given to an outstanding science teacher.

SANDRA KEEFE
B.T. Washington Middle School

VJAS Distinguished Service Award, most prestigious award given by the VJAS, is presented to a person for exceptionally outstanding service to the VJAS.

Dr. R. Dean Decker
Past Director, VJAS: Pres-Elect VAS

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James H. Martin

Dept. of Biology - PRC

J. Sargeant Reynolds Community College

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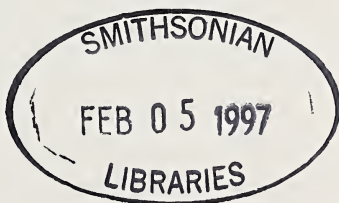
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The Expected Length of a Biased Random Walk

J. N. Boyd and P. N. Raychowdhury

Department of Mathematical Sciences

Virginia Commonwealth University, Richmond, Virginia 23284-2014

ABSTRACT

In this note, we find the expected length of a biased random walk on a linear array of points and connecting segments. The endpoints serve as traps or absorbing boundaries for the walk. The probabilities of moving from any interior point to its two nearest neighbors are p and $1 - p$, $0 < p < 1$. When $p \neq \frac{1}{2}$ the walk is said to be biased. The work proceeds from a specific case to the general result suggested by the initial computations.

We show that the expected length of a walk beginning at the i -th point in an array of n points is given by

$$E(n, i) = A + Bi + C \left(\frac{p}{1-p} \right)^{n-1}$$

where the values of the constants A, B and C are found in terms of $p \in (0, \frac{1}{2}) \cup (\frac{1}{2}, 1)$.

INTRODUCTION

It is so obvious that it becomes a cliché to say that old mathematics finds new uses. Nevertheless, the idea deserves to be noted. Arising in classical probability theory, the problem of a random walk from location to location in physical space or from state to state in some abstract space finds extensive use in contemporary applied mathematics.

Random walks model diffusion processes of interest to physicists (Feynman, 1963) and biologists (Murray, 1993). Their relevance to electrical circuits is well known (Doyle and Snell, 1984), and they find application in computer science (Kruse, Leung, and Tondo, 1991). The random walk which we shall present is one dimensional.

Let us consider the points $x = 0, 1, 2, \dots, n$ on a coordinate axis. The endpoints $x = 0$, $x = n$ serve as traps for a random walk on the array in which each step has unit length (Figure 1). The probability of moving from x to $x + 1$ for $x = 1, 2, 3, \dots, n - 1$ is p where $p \in (0, \frac{1}{2}) \cup (\frac{1}{2}, 1)$. The probability of each step toward $x = 0$ (from x to $x - 1$) is $1 - p$. The walk is said to be biased in the direction determined by the greater of p and $1 - p$.

Although the random walk is easy to describe, it is also quite easy to ask difficult questions about such a stochastic process. There was one particular question which we thought that we should be able to answer with methods and ideas no more sophisticated than those which are developed in an undergraduate, introductory probability and statistics course. That question was "What is the expectation value for the length of the random walk which we have described?"

We have done our mathematics with an "economy of means." Only after obtaining our results did we learn that the problem is a variant of "The Gambler's Ruin." (Feller, 1968). Since we are unable to claim anything in the way of an original result, we take comfort in citing a remark made by the distinguished mathematician R. Hamming:



FIGURE 1. The array for the random walk.

"The best thing that ever happened in the world is burning the library in Alexandria because it removed a millstone from around people's necks." Our reading of Hamming's statement is that originality is not everything in mathematics and too strict an insistence upon it stifles creativity (Albers and Alexanderson, 1985). We are of the opinion that our work remains interesting as a straightforward, intuitive attack upon a nontrivial problem most appropriate to undergraduate probability and statistics.

In our note, we compute the expected length of the random walk as a function of n (where there are $n + 1$ points) and of $i \in \{0, 1, 2, \dots, n\}$, the coordinate of the starting point of the walk. We denote the expected value by $E(n, i)$. We provide a path of discovery leading from a specific example to a general result. The computations involve the method of successive differences, a technique which is somewhat neglected in undergraduate mathematics these days.

A SPECIAL CASE

First, we consider a special case in hopes that its solution will direct us toward the general result. We take that to be the case for $p = \frac{2}{3}$

From the interior point for which $x = i$, the probability of a step to the left (to $i - 1$) is $\frac{1}{3}$ and the probability of a step to the right (to $i + 1$) is $\frac{2}{3}$. Since one step takes the walk to a new "starting point", we can write a recursion relation for the expected length

$$\begin{aligned} E(n, i) &= \frac{1}{3}(1 + E(n, i - 1)) + \frac{2}{3}(1 + E(n, i + 1)) \\ &= \frac{1}{3} E(n, i - 1) + \frac{2}{3} E(n, i + 1) + 1. \end{aligned} \quad (1)$$

Then a bit of algebraic manipulation yields

$$3 E(n, i) = E(n, i - 1) + 2 E(n, i + 1) + 3. \quad (2)$$

At the endpoints $i = 0$ and n , we have $E(n, 0) = E(n, n) = 0$. The endpoint values are our boundary conditions.

Solving the system of linear equations defined by Equation 2 with $i = 1, 2, 3, \dots, n - 1$ and the boundary conditions for $n = 3, 4, 5$ yields

$$\begin{aligned} E(3, 0) &= 0, E(3, 1) = \frac{15}{7}, E(3, 2) = \frac{12}{7}, E(3, 3) = 0; \\ E(4, 0) &= 0, E(4, 1) = \frac{17}{5}, E(4, 2) = \frac{18}{5}, E(4, 3) = \frac{11}{5}, E(4, 4) = 0; \text{ and} \\ E(5, 0) &= 0, E(5, 1) = \frac{147}{31}, E(5, 2) = \frac{174}{31}, E(5, 3) = \frac{141}{31}, E(5, 4) = \frac{78}{31}, E(5, 5) = 0. \end{aligned}$$

0	$\frac{147}{31}$	$\frac{174}{31}$	$\frac{141}{31}$	$\frac{78}{31}$	0
	∇	∇	∇	∇	∇
	$\frac{147}{31}$	$\frac{27}{31}$	$\frac{-33}{31}$	$\frac{-63}{31}$	$\frac{-78}{31}$
		∇	∇	∇	∇
		$\frac{-120}{31}$	$\frac{-60}{31}$	$\frac{-30}{31}$	$\frac{-15}{31}$
			∇	∇	∇
			$\frac{-60}{31}$	$\frac{30}{31}$	$\frac{15}{31}$
				∇	∇
				$\frac{-30}{31}$	$\frac{-15}{31}$
					∇
					$\frac{15}{31}$

FIGURE 2. The Successive Differences.

Seeking a pattern for $E(n, i)$ as n varies, we next examine the successive differences $E(n, i) - E(n, i-1)$ for $n = 3, 4$, and 5. The tableau of differences from $n = 5$ is given in Figure 2.

These computations suggest that

$$E(n, i) = A + Bi + C2^{n-i}$$

with the constants to be determined.

Equation 2 implies that $B = -3$ while $E(n, 0) = E(n, n) = 0$ implies that

$$A = \frac{3n2^n}{2^n - 1} \text{ and } C = \frac{-3n}{2^n - 1}.$$

Thus

$$E(n, i) = \frac{3n2^n}{2^n - 1} - 3i - \frac{3n2^{n-i}}{2^n - 1}. \quad (3)$$

A bit of algebraic manipulation shows that Equation 3 satisfies Equation 2 and the boundary conditions. If a second function $F(n, i)$ also satisfies Equation 2 and the boundary conditions, then $G(n, i) = E(n, i) - F(n, i)$ satisfies

$$G(n, i) = \frac{1}{3}G(n, i-1) + \frac{2}{3}G(n, i+1)$$

for $i \in \{1, 2, 3, \dots, n-1\}$ and $G(n, 0) = G(n, n) = 0$. It follows by reasoning analogous to that for discrete harmonic functions agreeing at all boundary points that $G(n, i) \equiv 0$ and that $E(n, i) \equiv F(n, i)$ (Boyd and Raychowdhury, 1989; 1992). Therefore, $E(n, i)$ in Equation 3 is the unique solution for $p = \frac{2}{3}$

THE GENERAL CASE

Let $1-p$ and p replace $\frac{1}{3}$ and $\frac{2}{3}$ respectively, in Equation 1. Then we are led to consider

$$E(n, i) = (1-p)E(n, i-1) + pE(n, i+1) + 1. \quad (4)$$

Let us assume that $E(n, i) = A + Bi + C\left(\frac{p}{1-p}\right)^{n-1}$ and pursue the consequences of that assumption.

Letting $E(n, i)$ take its assumed form in Equation 4 implies that $B = \frac{1}{1-2p}$. Letting $i = 0$ and $i = n$ in the assumed form yields

$$A + C\left(\frac{p}{1-p}\right)^n = 0 \quad \text{and}$$

$$A + C = \frac{-n}{1-2p}.$$

Solving these equations, we find that

$$C = \left(\frac{n}{1-2p}\right) \bigg/ \left[\left(\frac{p}{1-p}\right)^n - 1 \right] \quad \text{and}$$

$$A = -\left(\frac{p}{1-2p}\right)^n \left(\frac{n}{1-2p}\right) \bigg/ \left[\left(\frac{p}{1-p}\right)^n - 1 \right].$$

We observe that A , B , and C reduce to the values in the special case when $p = \frac{2}{3}$.

Algebraic manipulation shows that the assumed solution does indeed satisfy Equation 4 and the boundary conditions. A generalization of the uniqueness argument in the special case holds as well.

Thus

$$E_{(n, i)} = A + Bi + C \left(\frac{p}{1-p} \right)^{n-i}$$

is the general solution for $p \in \left(0, \frac{1}{2} \right) \cup \left(\frac{1}{2}, 1 \right)$ with A, B, C having the values given above.

DISCUSSION AND EXTENSIONS

The reader may verify that $\lim_{p \rightarrow 0^+} E(n, i) = i$ and $\lim_{p \rightarrow 1^-} E(n, i) = n - i$ for $i \in \{1, 2, 3, \dots, n-1\}$ thus justifying that $E(n, i) = i$ and $E(n, i) = n - i$ for $p = 0$ and $p = 1$, respectively. These results on the interior of the array are as expected.

When $p = \frac{1}{2}$, Equation 4 becomes

$$E(n, i) = \frac{1}{2} (E(n, i-1) + E(n, i+1)) + 1. \quad (5)$$

As we have previously shown (Boyd and Raychowdhury, 1991),

$$E(n, i) = ni - i^2$$

uniquely satisfies Equation 5 for $E(n, 0) = E(n, n) = 0$.

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Graminicolous Fungi of Virginia: Fungi Associated with Genera *Aegilops* to *Digitaria*

Curtis W. Roane¹ and Martha K. Roane²

Department of Plant Pathology, Physiology and Weed Science
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

ABSTRACT

Fungus-grass associations for grass species in the genera *Aegilops* through *Digitaria* occurring in Virginia are listed here below. Included are associations we have found and those from other published lists. New associations for Virginia are designated as new records (NR, V), for the United States (NR, U) and for eastern U.S. (NR, EU); the last named implies east of the Mississippi River. We made no attempt to determine whether or not a fungus is parasitic although many fungi are clearly the cause of lesions. Rust and powdery mildew fungi are obligate parasites; smut fungi are obviously parasitic. In our observations, the mere presence of a fungus is sufficient for us to regard it as a member of our mycoflora.

INTRODUCTION

Many fungi are known to occur on grasses in Virginia. We recently published an annotated list of those associated with cereals (Roane & Roane, 1994). Incidental to our travels around Virginia we have been collecting and identifying graminicolous fungi for many years. Since our retirement in 1986, we have engaged in a more concerted effort to find such fungi. Even so, the ensuing reports show a concentration of effort in Montgomery and the surrounding counties. The Coastal Plain and Piedmont species are poorly represented; there is little we can do to rectify the haphazardness of our collections. However, numerous host-fungus associations we have encountered are previously unreported for Virginia and several are unreported for the United States. Therefore, we deem it important to record our observations and to integrate them with those previously reported. This assemblage of reports will add to the literature on the natural history of Virginia.

The grasses of Virginia were recently listed by Roane (1991) and distribution maps for most species have been published by Harvill et al. (1986). In order to simplify the accessibility of our notations, the host species will be listed alphabetically; for each host the fungus species will be listed under its major fungus class. Thus, the procedures to be followed are generally those of Farr et al. (1989), and Roane & Roane (1994). New records will be designated by NR followed by V, EU, or U, symbolizing Virginia, Eastern United States (generally east of the Mississippi River), or United States, respectively, based upon the records and distributions given by Farr et al. (1989). Our collections are designated by year and accession number (ex., 90-32). There was no

¹ Professor Emeritus

² Retired Adjunct Professor

effort to determine by inoculation whether fungi were pathogenic or saprophytic and no fungi were isolated or cultured. Thus, all determinations were made from structures *in situ*. Specimens were often incubated in moist chambers to stimulate sporulation.

Prior to 1940, the federal plant research station was Arlington Farm, site of the Pentagon Building. Several plant pathologists working there lived in northern Virginia. Since some were forage crop and turfgrass specialists, they collected and identified fungi on both native and introduced species. This will account for some of the records on seemingly exotic species which were cultivated and evaluated for various purposes. Most of the records are unavailable concerning the locality and date of collection. They are listed as occurring in Virginia by Farr et al. (1989) who cite Agricultural Handbook No. 165 (1960) as the original source of information. Those fungi listed by Farr et al. as being in Virginia and which we have not collected will be listed generally without comment at the end of each host genus and will be designated by the symbols My, M, O, A, B, Dh, and Dc for Myxomycetes, Mastigomycotina, Oomycetes, Ascomycotina, Basidiomycotina, Deuteromycotina-Hyphomycetes, and Deuteromycotina-Coelomycetes. We will also designate State Parks by S.P.

We have issued some preliminary reports on this work (Roane & Roane, 1984, 1985, 1991).

Aegilops cylindrica L., goatgrass

Only one colony of *A. cylindrica* is known to us; it lies strung out for one-half mile along the railroad west of Whitethorne in Montgomery Co. All fungi were identified from collections made there; all records are new for Virginia, most are new for the United States.

Ascomycotina:

Mycosphaerella sp. - A species of *Mycosphaerella* was common on senescent leaves (Coll. 95-26C). Ascospores were fusiform, biseriate in the ascus and measuring 12-15 X 3.5-4.0 μ m. The fungus appears to fit *M. recutita* (Fr.) Johanson (Dennis, 1978; Ellis & Ellis, 1985). If properly identified, we have found it on other grasses. We hesitatingly report it as new. (NR, U).

Phaeosphaeria tritici (Garov.) Hedjaroude was mixed with the *Mycosphaerella* collection above (95-26C), but only two ascomata were found. The fungus was assigned to *P. tritici* based on the description by Shoemaker and Babcock (1989). (NR, U).

Basidiomycotina - Uredinales:

Puccinia recondita Roberge ex Desmaz., leaf rust. A few uredineal pustules occurred on leaves collected June 14, 1990 (90-32). A nearby wheat nursery may have furnished inoculum. (NR, U).

Deuteromycotina - Hyphomycetes:

Bipolaris sorokiniana (Sacc.) Shoemaker. One incubated leaf (Coll. 95-26C, June 27, 1995) produced dark brown, 6-9-septate conidia measuring 60-72 X 18-23 μ m, typical of this species. Since we found the fungus in a relatively small sample, it is probably common on *A. cylindrica*. (NR, U).

Fusarium avenaceum (Fr.:Fr.) Sacc. An incubated spike, (Coll. 96-26D, June 27, 1995) produced masses of salmon or peach colored, 3-5-septate macroconidia meas-

uring 48-62 X 3-4 μm . As noted above, our sample was very small; therefore, this fungus is probably a common colonizer of *A. cylindrica* spikes. (NR, U).

Fusarium sporotrichioides Sherb., head blight. A collection of June 12, 1991 (91-35B) was found to have spikes colonized by a *Fusarium* sp. with macroconidia measuring 27-45 X 3-5 μm and having 1-5 septa but mostly 3 septa. The spores were broader and shorter than those of *F. avenaceum*. *Fusarium acuminatum* was observed on *A. cylindrica* by Sprague (1950) causing root rot; no head blights have been reported. (NR, U).

Deuteromycotina - Coelomycetes:

Ascochyta graminea R. Sprague & Johnson, on senescent leaves. Only one collection, June 14, 1990, has been found (90-32). Pycnidiospores measured 12-19 X 4-6 μm much broader than in the following species. (NR, U).

Ascochyta sorghi Sacc. was associated with leaf spots and was prevalent on senescent leaves. We have found this fungus on all specimens of the host. Pycnidiospores measured 12-18 X 2-3 μm . Collections have been made in three different years (90-32, 91-35A, -B, 95-13) all in June. (NR, EU).

Colletotrichum graminicola (Ces.) G. W. Wilson, anthracnose, occurred on leaves and culms of every collection we made. The fungus produced lesions and colonized senescent structures. It occurs in the several collections we made (90-32, 91-35A, -B, 95-13, 95-26A), and on V.P.I. & S.U. Herbarium specimens from Campbell Co. (VPI & SU Herb. No. 13458), Clark Co. (No. 13459), Rockingham Co. (No. 18466), and Russell Co. (No. 13455).

Stagonospora nodorum (Berk.) Castellani & Germano, node rot. This fungus is well known as *Septoria nodorum* (Berk.) Berk. causing glume blotch of wheat. Collections exist from June 12, 1991 and June 27, 1995 (91-35A, 95-26B). (NR, U).

Agropyron repens (L.) Beauv., syn., *Elytrigia repens* (L.) Nevski, quackgrass

Ascomycotina:

Claviceps purpurea (Fr.:Fr.) Tul., ergot. This fungus is widespread on *A. repens* and is easily recognized by the prominent purplish pseudosclerotia protruding from spikelets as the host nears maturity. Specimen 82-Ar-7 of our collection is the anamorphic stage *Sphacelia segetum* Lev., which precedes the sclerotial stage. Farr et al. (1989) describe *C. purpurea* as occurring in the range of the host.

Erysiphe graminis DC., syn., *Blumeria graminis* (DC.) E.O. Speer, powdery mildew, occurs throughout the range of the host (Farr et al., 1989), thus is widespread on *A. repens* in Virginia. Collections 83-Ar-7, and 91-15 are from Blacksburg, Montgomery Co., June 14, 1983, and May 2, 1991, respectively.

Mycosphaerella recutita (Fr.) Johnson, associated with leaf spots, was collected June 27, 1995 on Kentland Farm (VPI & SU), Whitethorne, Montgomery Co. Ascomata had no paraphyses; ascospores were biserial, hyaline, 1-septate, cylindrical, measuring 12-13 X 4 μm . Identification was based on the description by Ellis & Ellis (1985). (NR, U).

Phomatospora dinemasporium Webster is described as being widespread on dead grass stems (Ellis & Ellis, 1985, p. 465). It is most frequently found in the anamorphic stage, *Dinemasporium strigosum* (Pers.:Fr.) Sacc. It was found on *A. repens* in

Blacksburg, Montgomery Co., July 11, 1989 (89-Ar-1), on overwintered stems. (NR, U).

Phyllachora graminis (Pers.:Fr.) Nitschke, tar spot, occurs frequently on *A. repens* in Montgomery Co. We have two collections (82-Ar-10, 84-Ar-7) made in July and October, 1982 and 1984, respectively. (NR, V).

Basidiomycotina - Uredinales:

Puccinia coronata Corda, crown rust, may be found on *A. repens* in Montgomery Co. throughout the host's growing season. Apparently it survives in the uredinal stage as the alternate hosts, *Rhamnus* spp., are uncommon in this area. We have two collections from Montgomery Co., 91-15, 91-42, made May 2, and June 12, 1991, respectively. (NR, V).

P. graminis Pers., black stem rust, occurs sporadically on grasses in the mountains of western Virginia. We have encountered it on *A. repens* only once (83-Ar-1) in Montgomery Co. near the junction of Rts. 657 and 685 in November, 1983. (NR, V).

P. recondita Roberge ex Desmaz., leaf rust, is common on *A. repens* in the Montgomery Co. region of Virginia yet Farr et al. (1989) report its occurrence only from West Virginia and South Dakota. We have collections made in June from Whitethorne, Montgomery Co. (90-34, 95-25) and Claytor Lake S.P., Pulaski Co. (89-11). (NR, V).

Basidiomycotina - Ustilaginales:

Urocystis agropyri (Preuss.) Schroet., flag smut, occurs in the northeastern states as far south as Pennsylvania, according to Farr et al. (1989). Specimens were collected in June 1982 and July 1983 from the same colony of *A. repens* in Montgomery Co. in successive years (82-Ar-6, 83-Ar-6), thus extending its range into southwestern Virginia. (NR, V).

Deuteromycotina - Coelomycetes:

Ascochyta graminea (Sacc.) R. Sprague & A. G. Johnson was found on specimens from a single colony of *A. repens* in Blacksburg. Spores were 13-16 X 3.5-5.0 μ m, generally shorter and broader than in *A. sorghi*; it was collected May 2, 1991 in Montgomery Co. (91-15). NR, U.

A. sorghi Sacc. was found in Blacksburg and near Whitethorne, Montgomery Co. May 2, and June 12, 1991. Spores measured 12-20 X 2-4 μ m. Farr et al. (1989) list it only as in Massachusetts in Eastern U.S. (NR, V).

Additional species reported as occurring in Virginia (Farr et al., 1989): *Drechslera gigantea* (Heald & Wolf) Ito, *D. tritici-repentis* (Died.) Shoem.

Agrostis spp., bentgrass, hairgrass, redtop

Eleven species of *Agrostis* L. are listed by Roane (1991) as occurring in Virginia. Some are turf grasses and some are Coastal Plains species. We have identified fungi on five species. Farr et al. (1989) list several fungi from Virginia that we have not encountered. These will be appended to the end of our list. Here the host species are numbered; in the text, the numbers will refer to these hosts:

1. *Agrostis alba* L. (including *A. stolonifera* L.), redtop.
2. *A. gigantea* Roth. - *Agrostis alba*, *A. gigantea*, *A. palustris*, and *A. stolonifera* are taxonomically related and the latter three may be subspe-

cies of *A. alba*. A specimen identified as *A. gigantea* by T. F. Wieboldt, V.P.I. & S.U. Herbarium, was found to harbor several interesting fungi. A single collection was made along Stroubles Ck. on the university farm between the beef and swine barns, Blacksburg, Montgomery Co., Sept. 2, 1994.

3. *A. hiemalis* (Walt.) B.S.P. (also *A. hyemalis*), hairgrass.
4. *A. perennans* (Walt.) Tuck, autumn bentgrass.
5. *A. scabra* Willd., rough bentgrass.

Ascomycotina:

Epichloe typhina (Pers.:Fr.) Tul., causing choke disease, was found in a large colony of 4 growing in an abandoned logging road on the south slope of Gap Mt. about 5 mi. west of highway U.S. 460, northwestern Montgomery County, July 1983 and 1984 (83-Ap-1, 83-4, 84-Ap-7b). A strong mushroom-like odor was associated with developing stromata. The colony was observed throughout the summer for two years. A brief report has been published (Roane & Roane, 1984).

Mycosphaerella tulasnei (Jancz.) Lindau occurred on sheaths of 4 at the choke site on Gap Mt., Montgomery Co., July 14, 1984 (84-Ap-7a). The fungus clearly fitted the description of *M. tulasnei* given by Sprague (1950). (NR, EU).

Phaeosphaeria nigrans (Roberge ex Desmaz.) L. Holm occurred on foliage of a collection of 4 from under trees south of the swimming pavillion at Claytor Lake S.P., Pulaski Co., Aug. 2, 1989 (89-27). Ascospores were 5-septate, 20-22 X 4-5 μ m, the second cell enlarged. This is a plurivorous fungus and, thus, could occur on many grass hosts (Shoemaker & Babcock, 1989). (NR, U).

Basidiomycotina:

Puccinia coronata Corda, crown rust, occurred on 1 along Stroubles Ck. below the U.S. 460 by-pass, V.P.I. & S.U. farm, Montgomery Co., Sept. 2, 1994 (94-50). Typical teliospores (stage III) bearing terminal processes were present. (NR, V). Stages II and III were prevalent on 4 at the choke site above, viz., south slope of Gap Mt., Montgomery Co. (83-Ap-1, 83-4, 84-Ap-7). Farr et al. (1989) do not list *A. perennans* as a host. (NR, U).

Puccinia graminis Pers., stages II and III, black stem rust, was collected on 1 at the Stroubles Ck. site above (NR, V), and on 2 at the same location (94-53). (NR, EU).

Puccinia recondita Roberge ex. Desmaz., II, III, was collected on 5 along Big Reed Island Ck. above the confluence with Greasy Ck. in Carroll Co., Apr. 19, 1992 (92-14). (NR, V).

Thanatephorus cucumeris (A. B. Frank) Donk is listed by Farr et al. (1989) as a cause of brown patch of 1 in Virginia. The fungus is better known by its anamorphic name, *Rhizoctonia solani* Kuehn. It is frequently found on specimens sent to the V.P.I. & S.U. Plant Clinic.

Deuteromycotina - Hyphomycetes:

Bipolaris sorokiniana (Sacc.) Shoem. fruited on incubated leaves of 2 collected along Stroubles Ck., V.P.I. & S.U. farm, Sept. 2, 1994 (94-53). (NR, U).

Curvularia geniculata (Tracey & Earl) Boedijn appeared on incubated leaves of 3 collected at Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-59-1). (NR, U).

Drechslera dematioidea (Bubák & Wróbl) Subram. & Jain, causing leaf spot and wilted leaves was collected in our yard in Blacksburg, Montgomery Co. on 1 July 16, 1990 (90-55). Conidia measured 24-45 X 14-17 μm and had 3-4-septa. (NR, V).

Drechslera erythrospila (Drechs.) Shoem. causing a red leaf spot was collected on 1 along the lake shore, Claytor Lake S.P., Pulaski Co., July 14, 1989 (89-2). Conidia measured 35 X 100 μm and were 2-10-septate. It is common on 1 in Virginia. A collection on 4 came from the hiking trail at the Mt. Rogers Recreation Area Headquarters, Rt. Va. 16, Smyth Co., Aug. 14, 1994 (94-29). Although it is widespread on other *Agrostis* spp., it is not reported on 4. (NR, U).

Mastigosporeum rubricosum (Dearn. & Barth.) Nannf. (Sprague, 1950; pp. 402-405) was found on 3 along War Branch Trail off Rt. 613, Giles Co., June 24, 1990 (90-42). It appears to be a primary pathogen. (NR, U).

Nigrospora sphaerica (Sacc.) Mason and *Stemphylium botryosum* Wallr. appeared within 24 hr on incubated leaves of 3 collected at Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-59-1). (NR, U, both fungi).

Deuteromycotina - Coelomycetes:

Ascochyta sorghi Sacc. causing wilted leaves was collected on 1 in our yard, Blacksburg, Montgomery Co., July 16, 1990 (90-55). (NR, V).

Colletotrichum caudatum (Sacc.) Peck fruited on a few leaves of 2 collected along Stroubles Ck., V.P.I. & S.U. farm, Montgomery Co., Sept. 2, 1994 (94-53). This fungus is also known as *Ellisiella caudata* (Peck) Sacc. Spores feature a tapering appendage (NR, U).

Colletotrichum graminicola (Ces.) G. W. Wils., the anthracnose fungus, is for grasses an omniphyte. If we search long enough, we may find it colonizing all grasses in our region. We have found it on four of the five *Agrostis* spp. examined. On 1 it was common on leaves and culms collected along Stroubles Ck., V.P.I. & S.U. farm, Montgomery Co., Sept. 2, 1994 (94-50), and along the lake shore, Claytor Lake S.P., Pulaski Co., July 14, 1989 (89-2). (NR, V). We collected it on 2 along Stroubles Ck., Sept. 2, 1994 (94-53). (NR, U). It occurred on plants of 4 under trees at Claytor Lake S.P., Aug. 2, 1989 (89-27). (NR, U). We found it on 5 collected along Big Reed Island Ck. above the confluence with Greasy Ck., Carroll Co., April 19, 1992 (92-14). (NR, U). Ubiquitous as it is, this fungus has not been reported previously by Farr et al. (1989) on any *Agrostis* sp. in Virginia.

Phyllosticta anthoxella R. Sprague was collected on 4 at the Mt. Rogers Recreation Area Headquarters on Va. 16, Smyth Co., Aug. 14, 1994 (94-29). Pycnosporos were bacilliform, 5-7 X 1.0-1.5 μm . It was reported previously only from Oregon on *Anthoxanthum* (Farr et al. 1989). (NR, U).

Phyllosticta sorghina Sacc. occurred on newly wilted leaves of 3 collected at the Eastern Virginia Research Station, Warsaw, Richmond Co., May 26, 1982 (82-Ah-5) and at Hungry Mother, S.P., Smyth Co., Sept. 3, 1989 (89-59-2). (NR, U). It occurred on 4 along the Appalachian Trail, west slope of White Top Mt., Grayson Co., above 5000', Aug. 31, 1989 (89-59). (NR, U).

Note: *P. sorghina* is assigned to *Phoma sorghina* (Sacc.) Boerema, Doren., & Van Kest. by Farr et al. (1989). The distinction between the genera appears to be arbitrary.

Septoria spp. are sometimes very difficult to separate. Although we have assigned our collections to two species, variation in spore morphology may have led us to err. No *Septoria* spp. are listed on *Agrostis* spp. east of the Mississippi River by Farr et al. (1989).

Septoria passerinii Sacc. having 3-septate spores measuring 24-35 X 1.5-2.0 μm was collected on **4** on Gap Mt., Montgomery Co., July 14, 1984 (84-AP-7). (NR, U). It was also found on **1** along the lake shore at Hungry Mother S.P., Smyth Co., Aug. 29, 1989 (89-41). Spores were 3-septate, occasionally 4-septate, measuring 20-30 X 1.5-2.0 μm mostly 25-28 X 1.8 μm . (NR, U).

Septoria secalis Prill. & Delacroix having 3-septate spores measuring 21-50 X 2-3 μm has been collected on **3** & **4**. A collection with 1-4-septate, mostly 3-septate spores measuring 35-47 X 2.5-3.5 μm was found causing leaf spots on **3** at Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-59-2). (NR, U). It was also found on **4** under trees at Claytor Lake S.P., Pulaski Co., Aug. 2, 1989 (89-27). Spores were 3-septate, measuring 21-35 X 2.0-2.5 μm . A collection causing leaf spots on **4** from the Mt. Rogers Recreation Area Headquarters, Va. 16, Smyth Co., Aug. 14, 1994 (94-29) had 3-septate spores measuring 35-50 X 2-3 μm . (NR, U).

Note: *Septoria passerinii* and *S. secalis* have different spore widths. Sprague (1950), whose key and descriptions we have used, lists *S. secalis* on rye but *S. secalis* var. *stipae* Sprague on *Agrostis*. The var. *stipae* has spores about 10 μm longer than *S. secalis*. Otherwise, they are similar.

Stagonospora foliicola (Bres.) Bubák occurred on newly wilted leaves of **3** collected at Hungry Mother S.P., Smyth Co., Sept. 3, 1989. Spores were typical of those illustrated by Sprague (1950, fig. 57A). (NR, U).

Sphaerellopsis filum (Biv.-Bern. ex Fr.) Sutton is not a parasite of grasses. We found it parasitizing *Puccinia coronata* on **4** collected on Gap Mt. at the rust collection site above, Montgomery Co., Aug. 16, 1983, Aug. 14, 1984 (83-AP-1, 84-AP-7) and parasitizing *P. recondita* on **5** along Big Reed Island Ck. in Carroll Co., Apr. 19, 1992 (92-14).

In addition to our collections, the following are reported by Farr et al. (1989) to occur on *Agrostis* spp. in Virginia. The letters preceding each fungus group are explained at the end of the introduction.

O - *Pythium aphanidermatum* (Edson) Fitzp. on *A. alba* and *A. capillaris* L.; A - *Phyllachora graminis* (Pers.:Fr.) Nitschke on *A. alba*; *Sclerotinia homoeocarpa* Bennett on *A. alba*, *A. canina*, and *A. capillaris*; B - *Thanatephorus cucumeris* (A. B. Frank) Donk on *A. alba*, *A. canina*, and *A. capillaris*; Dh - *Curvularia lunata* (Wakk.) Boedijn on *A. alba*; *Drechslera gigantea* (Heald & Wolf) Ito on *A. alba*, *D. triseptata* (Drechs.) Subr. & Jain on *A. alba*; Dc - *Cheilaria agrostis* Lib. on *A. alba*.

Andropogon gerardii Vitman, big bluestem

Ascomycotina:

Phyllachora americana D. G. Parbery, causing tar spot, occurred along Va. 8, 1 mi. N. of Rt. 807, in a field next to Dodds Creek, Floyd Co., Sept. 26, 1994 (94-57). Although cited by Farr et al. (1989) as occurring on *Andropogon* sp., it had only been collected on *A. gerardii* in Georgia and Florida. (NR, V).

Basidiomycotina:

Puccinia andropogonis Schwein., II, III, causing a rust, was collected at the site above (94-57). It is prevalent throughout the eastern states (A.H. 165, 1960).

Deuteromycotina - Hyphomycetes:

Fusarium sambucinum Fuckel was parasitic on *Phyllachora americana* collected at the Va. 8 site above (94-57). (NR, V).

Nigrospora sphaerica (Sacc.) Mason appeared in incubated leaves collected along Sinking Creek in Giles County near the Craig Co. line, Oct. 3, 1994 (94-69). Most likely it is a saprophyte. (NR, V).

Tetraploa aristata Berk. & Broome appeared on incubated leaves from the Va. 8 site (94-57). No doubt this is a saprophyte. (NR, V). *T. ellisii* is listed by Farr et al. (1989) as occurring on *Andropogon* sp. in Alabama.

Deuteromycotina - Coelomycetes:

Colletotrichum graminicola (Ces.) G. W. Wils. was collected near the Norfolk Southern Rwy., S. of Va. 114, Montgomery County, Nov. 7, 1982 (82-Ag-11), and along Sinking Creek in Giles County near the Craig Co. line, Oct. 3, 1994 (94-69). (NR, V).

Phyllosticta andropogonivora R. Sprague & Rogers was found on a V.P.I. & S.U. Plant Clinic specimen (Cl. no. 94-1219) sent in from James City County, Aug. 11, 1994 (94-36). We also collected it at the Va. 8 site above, Sept. 26, 1994 (94-57). These are the first collections from the eastern states. (NR, EU).

Andropogon virginicus L., broomsedge

Basidiomycotina:

Uromyces andropogonis Tracy, III, was collected at the marina cove in Claytor Lake S.P., Pulaski Co. on overwintered culms, Apr. 17, 1991 (91-10); stages II and III were found on fall culms, Nov. 2, 1987, in the same area (87-Av-1). This rust fungus-host association is common in the eastern states (Farr et al., 1989).

Deuteromycotina - Coelomycetes:

Colletotrichum graminicola (Ces.) G. W. Wils. was collected along the lake shore in Claytor Lake S.P., Pulaski Co., in June 1989, and Aug. 2, 1989 (89-7, 89-16). (NR, U).

Phoma sorghina (Sacc.) Boerema., Doren., & Van Kest. occurred with *C. graminicola* in the June collection (89-7). Spores measured 4-5 X 1.5-2.0 μ m. These spores are smaller than those of other species reported on *Andropogon*. (NR, U).

Deuteromycotina - other:

Rhizoctonia solani Kuehn, causing summer blight is common on broomsedge at Claytor Lake S.P. We have observed it many times and collected it in June 1989 (89-7). (NR, V).

Other fungi reported by Farr et al. (1989) to occur on *Andropogon* spp. in Virginia are:

A - *Balansia henningsiana* (Moell.) W. W. Diehl on *A. scoparius* Michx. (see also Diehl, 1950), *Phyllachora luteo-maculata* (Schwein.) Orton on *A. virginicus*; B - *Puccinia ellisiana* Thuem. on *A. virginicus*, *Sorosporium ellisii* G. Winter on *A.*

gerardii, *S. everhartii* Ellis & B. T. Galloway on *A. spp.* (unspecified), *Sphacelotheca monilifera* (Ellis & Everh.) Clinton on *A. glomerata* Vitm., *S. seymouriana* Clinton on *A. gerardii*.

Anthoxanthum odoratum L., sweet vernalgrass

Ascomycotina:

Phaeosphaeria eustoma (Fuckel) L. Holm was collected at the marina cove, Claytor Lake S.P., Pulaski Co., May 30, 1991 (91-23). (NR, U). No ascomycete has been reported on this grass (Farr et al., 1989). (NR, U).

Basidiomycotina:

Puccinia graminis Pers., II, was collected on the VPI & SU Horticulture Farm (now the Market Place Shopping Center), Montgomery Co., June 28, 1989 (89-Ao-2) and on Kentland Farm, VPI & SU, Montgomery Co., June 13, 1990 (90-33). Both specimens were identified by J. F. Hennen, Purdue Univ., former curator of rust collections. A collection was made at the picnic area parking lot, Fairy Stone S.P., Patrick Co., May 23, 1993 (93-5). Although known from several eastern states, it has not been reported from Virginia (Farr et al., 1989). (NR, V).

Puccinia recondita Roberge ex. Desmaz. came from Claytor Lake S.P., Pulaski Co., May 30, 1991 (91-23). This is a new host for this fungus according to Farr et al. (1989) but Cummins (1971) lists *Anthoxanthum* sp. as a host. (NR, U).

Deuteromycotina - Hyphomycetes:

Cercosporidium graminis (Fuckel) Deighton was collected at Kentland Farm, Whitethorne, Montgomery Co., June 13, 1990 (90-33). This fungus has a wide host range but has not been recorded on this host before (Farr et al., 1989). (NR, U).

Drechslera dematioidea (Bubák & Wróbl.) Subram. & P. C. Jain, causing leaf spot, was collected at several locations: VPI & SU Horticulture Farm (now the Market Place Shopping Center), Montgomery Co., June 22, 1989 (89-Ao-1); Claytor Lake S.P. in the picnic area Aug. 11, 1989 (89-32), and June 17, 1990 (90-37); at the marina cove, May 30, 1991 (91-23), Pulaski Co.; Adner, Gloucester Co., June 24, 1991 (91-44); Rt. 619, Indian Valley, Floyd Co., July 4, 1991 (91-60); Blue Ridge Pkwy., near Goundhog Mt., Carroll Co., June 18, 1995 (95-21). Although it is a common leaf spotter on *Anthoxanthum* and is reported in several eastern states, this fungus has not been reported from Virginia (Farr et al., 1989). (NR, V).

Volutella ciliata (Alb. & Schwein.) Fr. fruited on incubated leaves collected in the picnic parking area, Fairy Stone S.P., Patrick Co., May 25, 1993 (93-5). This is probably a strict saprophyte. It is not listed by Farr et al. (1989); Ellis & Ellis (1985) describe it as, "Very common on dead herbaceous plants, Oct.-Apr., and best seen in the field after a shower of rain." It has a fringe of long white setae at the base of the sporodochium. (NR, U).

Note: In contrast, *Amerosporium atrum* (Fuckel) Höhn., is similar in appearance but has dark setae at the base. We have encountered both fungi on several grass collections.

Deuteromycotina - Coelomycetes:

Ascochyta sorghi Sacc., associated with purple-brown leaf spots and dead leaf tips, was collected at the picnic parking area, Fairy Stone S.P., Patrick Co., May 23, 1993 (93-5) and along the Blue Ridge Pkwy., near Groundhog Mt., Carroll Co., June 18, 1995 (95-21). It was reported previously only from West Virginia (Farr et al., 1989). (NR, V).

Colletotrichum graminicola (Ces.) G. W. Wils., causing anthracnose, was collected twice at Claytor Lake S.P., Pulaski Co., once in the picnic area Aug. 11, 1989 (89-32) and once at the marina cove, May 30, 1991 (91-23). It was also collected in the picnic area parking lot at Fairy Stone S.P., Patrick Co., May 23, 1993 (93-5). The only eastern states report for this fungus-host association is from Kentucky (Farr et al., 1989). (NR, V).

Phyllosticta anthoxella R. Sprague was collected on leaves at the VPI & SU Horticulture Farm (now The Market Place), June 23, 1989 (89-Ao-2). Spores were slightly colored pale olive, 8-10 X 1.0-1.5 μm . This fungus is reported from Oregon only (Farr et al., 1989). (NR, EU).

P. minutaspora R. Sprague was present on the same collection (89-Ao-2). Spores measured 3.5-5.0 X 1.0-1.5 μm or about one-half the length of those of *P. anthoxella*. This fungus is not reported on *Anthoxanthum* (Farr et al., 1989). (NR, U).

Stagonospora arenaria Sacc. associated with purple-brown leaf spots, was collected in the picnic area, Claytor Lake S.P., Pulaski Co., June 17, 1990 (90-37); at Adner, Gloucester Co., June 24, 1991 (91-44); and at the picnic area parking lot, Fairy Stone S.P., July 24, 1994 (94-19). (NR, U). See note below.

S. maculata (Sacc.) Sacc., associated with leaf spots was collected at the picnic area, Claytor Lake S.P., Pulaski Co., Aug. 11, 1989 (89-32). (NR, U). See note below.

S. nodorum (Berk.) Cast. & Germano, associated with brown leaf spots, was collected at the VPI & SU Experiment Station, Warsaw, Richmond Co., May 15, 1982 (82Ao1). (NR, U). See note below.

Note: Spore measurements for the above: *S. arenaria*, 27-42 X 3-4 μm , not constricted at the septa; *S. maculata*, 26-32 X 3.5-4.0 μm , constricted at the septa; *S. nodorum*, 28-32 x 3-4 μm , usually broadest at the base. This fungus was prevalent on wheat nearby. None of the species has been reported on *Anthoxanthum* (Farr et al., 1989). Spore measurements and morphologies of the fungi conform to those given by Sprague (1950).

Sphaerellopsis filum (Biv.-Bern. ex Fr.) Sutton, was parasitic on *Puccinia recondita* in the Claytor Lake S.P. collection of May 30, 1991 listed above (91-23).

Farr et al. (1989) list no additional fungi on *A. odoratum* in our region.

Aristida oligantha Michx., prairie three-awn

Ascomycotina:

Monographella nivalis (Schaffnit) E. Müller & von Arx was collected on overwintered plants in a field off Country Club Dr., Blacksburg, Montgomery Co., Apr. 7, 1995 (95-3). (NR, U).

Deuteromycotina - Hyphomycetes:

Curvularia inaequalis (Shear) Boedijn appeared quickly on incubated leaves collected at edge of parking lot next to woods behind the marina-swimming area, Claytor Lake S.P., Pulaski Co., Oct. 30, 1995 (95-48). (NR, U).

C. protuberata Nelson & Hodges appeared on incubated, overwintered plants collected in the field behind Gables Shopping Center, Blacksburg, Montgomery Co., April 7, 1995 (95-3). (NR, U).

C. trifolii Boedijn appeared quickly on incubated leaves and culms collected near M.P. 126 at Mason's Knob overlook, Blue Ridge Pkwy., Roanoke Co., Oct. 23, 1995 (95-44). (NR, U).

Species of *Alternaria*, *Cladosporium*, and *Stemphylium* also fruited on all *Aristida* collections.

Deuteromycotina - Coelomycetes:

Colletotrichum graminicola (Ces.) G. W. Wils., anthracnose, was collected at the Gables Shopping Center site and date as above (95-3). (NR, U).

Ellisiella caudata Sacc. was collected at the Pembroke rock quarry, Giles Co., Apr. 2, 1995 (95-6). (NR, U).

In addition, Farr et al. (1989) list the following on *Aristida* spp. in Virginia:

A - *Balansia aristidae* (Atk.) Diehl on *Aristida* sp.; B - *Uromyces seditiosus* F. Kern on *A. purpurascens* Poir.

Arrhenatherum elatius (L.) J. Presl. & K. Presl., tall oatgrass

Ascomycotina:

Phaeosphaeria luctuosa (Niessl) Otani & Mikawa occurred on dead culms at 607 Lucas Dr., Blacksburg, Montgomery Co., Sept. 12, 1989 (89-Ae-3). (NR, U).

P. nodorum (E. Müller) Hedj. occurred on leaves and culms at the old VPI & SU Horticulture Farm (now The Market Place), Montgomery Co., June 28, 1989 (89-Ae-1), and at 607 Lucas Dr., Blacksburg, Montgomery Co., June 23, 1989 (89-Ae-3). (NR, U).

Basidiomycotina:

Puccinia coronata Corda, II, III, crown rust, was collected at Rt. 700 and Sinking Ck., Giles Co., Nov. 14, 1981 (81-Ae-1); at 607 Lucas Dr., Blacksburg, Montgomery Co., July 8, 1983 (83-Ae-1); June 25, 1989 (89a), June 27, 1990 (90-52), June 21, 1995 (95-24); and at North Main St. near U.S. 460, July 1991 (91-x). It is reported by Farr et al. (1989) only in West Virginia of the eastern states. (NR, V).

Deuteromycotina - Hyphomycetes:

Rhynchosporium orthosporum Caldwell, causing scald, was collected at Pearisburg, Giles Co., near the Norfolk Southern Rwy., June 14, 1989 (89-Ae-1). (NR, U).

Spermospora avenae (R. Sprague & Johnson) R. Sprague, a cause of red leather leaf, was collected at 607 Lucas Dr., Blacksburg, Montgomery Co., July 8, 1983 (83a), at the Pearisburg site above (89-Ae-1), and at the old VPI & SU Horticulture Farm, Montgomery Co., June 7, 1989 (89-Ae-2b). It is reported in the eastern states only from West Virginia (Farr et al., 1989). (NR, V).

S. subulata (R. Sprague) R. Sprague, causing blast, occurred in collection 89-Ae-21 above. Sprague (1950) illustrates *S. subulata* conidia as having a distal whip-like extension and Guba (1961) pictures *S. avenae* as having tapered extensions on each end. Both spore types were present but on different lesions (NR, U).

Deuteromycotina - Coelomycetes:

Ascochyta brachypodii (Sydow) R. Sprague & Johnson was collected at Rt. 700 and Sinking Ck., Giles Co., Nov. 14, 1981. Spores are broader than those of *A. sorghi*, the only other species recorded on *A. elatius* (Farr et al., 1989; Sprague, 1950). (NR, U).

Stagonospora avenae (Frank) Bissett was collected on the old VPI & SU Horticulture Farm, Montgomery Co., June 7, 1989 (89-Ae-2b) and at 607 Lucas Dr., Blacksburg, Montgomery Co., June 21, 1995 (95-24). It is known from West Virginia and Pennsylvania (Farr et al., 1989). (NR, V).

S. arenaria Sacc. was collected near M.P. 19, Blue Ridge Pkwy., on the Nelson-Augusta Co. line, June 25, 1991. (NR, U).

In addition, Farr et al. (1989) report B- *Ustilago avenae* (Pers.) Rostr., the cause of loose smut, as occurring in Virginia.

Arthraxon hispidus (Thunb.) Makino

No fungi have been reported previously on *A. hispidus* in Virginia (Farr et al., 1989).

Deuteromycotina - Hyphomycetes:

Bipolaris cynodontis (Marignoni) Shoem. was found on a specimen (VPI & SU Weed Ident. No. 93-288) sent from Albemarle Co., Aug. 12, 1993. (NR, U).

Periconia circinata (Mangin) Sacc. fruited on incubated leaves collected July 9, 1989, 1 mi. S. of the Floyd-Franklin line on Rt. 860 (89-Ah-1a). (NR, U).

Ramulispora sorghi (Ellis & Everh.) Olive & Lefebvre was also collected at the Rt. 860 site (89-Ah-1b). (NR, U).

Deuteromycetes - Coelomycetes:

Phyllosticta minutaspora Sprague fruited on dead leaf tips collected at the Rt. 860 site above (89-Ah-1b). (NR, U).

A *Phyllosticta* sp. having conidia measuring 9-10 X 3.5-4.0 μm fruited on the Albemarle Co. collection above. It has characteristics of *P. bromivora* Sprague (spores measuring 6-11 X 3.0-3.8 μm) but fits neither *Phyllosticta* perfectly. We refrain from assigning our specimen.

Arundinaria gigantea (Walt.) Muhl., giant cane

We have collected giant cane from only one site, the Experiment Station property at Holland, Suffolk (formerly Nansemond Co.).

Basidiomycotina:

Puccinia arundinaria Schwein., rust, was collected April 16, 1982 (82-Ag-1). A sample was sent to the J. C. Arthur Herbarium, Purdue University where its identity was verified by J. F. Hennen. Farr et al. (1989) report it from southeastern states but not specifically from Virginia. (NR, V).

Deuteromycotina - Coelomycetes:

Ascochyta sorghi Sacc. was also collected April 16, 1982 (82-Ag-1). No *Ascochyta* spp. have been reported on giant cane (Farr et al., 1989). (NR, U).

Farr et al. (1989) report only one other fungus on leaves of giant cane from Virginia, *Sclerotium sacidioides* Speg. This was the type specimen from which Spegazzini described the fungus. It is unknown elsewhere.

Axonopus affinis Chase, carpetgrass

We have not collected specimens of carpetgrass but Farr et al. (1989) list *Dh-Cerebella andropogonis* Ces., the cause of black heads, as occurring in Virginia. The fungus is illustrated and described by Ellis (1971).

Brachyelytrum erectum (Schreb.) Beauv., long-awned woodgrass

Specimens of *B. erectum* have been collected from three sites; only one fungus was detected.

Deuteromycotina - Coelomycetes:

Stagonospora brachyelytri Greene was collected at Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-42); in the woods behind the cabins at Claytor Lake S.P., Pulaski Co., June 21, 1991 (91-54); and at the Mt. Rogers Recreation Area Headquarters, Rt. 16, Smyth Co., Aug. 14, 1994 (94-27). The fungus is associated with elongated leaf spots (Sprague, 1950), and apparently is widespread in eastern states (Farr et al., 1989). (NR, V).

Bromus spp., brome grass, chess, cheat

In order to conserve space, the host species are listed and numbered. In the collection records, the hosts will be cited by number.

1. *B. ciliata* L. - fringed brome.
2. *B. commutatus* Schrad. - hairy chess.
3. *B. inermis* Leyss. - smooth brome.
4. *B. japonicus* Thunb. ex Murray - Japanese brome.
5. *B. latiglumis* (Shear) Hitchc.
6. *B. purgans* L. - Canada brome.
7. *B. sterilis* L. - barren brome.
8. *B. tectorum* L. - downy cheat

Ascomycotina:

Claviceps purpurea (Fr.:Fr.) Tul., ergot occurs in almost all stands of 3. We collected it only along Prices Fork Road opposite the entrance to Hethwood, Montgomery Co., Aug. 15, 1983 (83-Bi-1). Farr et al. (1989) report the fungus from the entire range of 3.

Phaeosphaeria herpotrichoides (De Not.) L. Holm, associated with leaf spots on 5 was collected at the Craig Ck. Recreation Area, Jefferson National Forest, Oriskany, Botetourt Co., July 31, 1994. (NR, U).

P. luctuosa (Niessl) Otani & Mikawa, was collected on 1 near the mouth of Norris Run, N.W. Montgomery Co., July 1981 (81-Bc-1). Farr et al. (1989) report no *Bromus* spp. as hosts of this fungus. (NR, U).

P. nigrans (Roberge ex Desmaz.) L. Holm. has been collected on **4** near Grayson-town, Pulaski Co., June 11, 1990, (90-27) (NR, U); on **6** Rt. 712, Ellett, Montgomery Co., June 6, 1990, (90-22) (NR, U); on **7** at the Rt. 613 bridge over Little R., Snowville, Montgomery Co., June 11, 1990 (90-29). (NR, U).

Phyllachora graminis (Pers.:Fr.) Nitschke, causing tar spot, was collected on **1** at Eggleston, Giles Co., Nov. 15, 1981 (81-Bc-2). (NR, U).

Basidiomycotina:

Puccinia recondita Roberge ex Desmaz., leaf rust, stage III, was collected on **1** near the mouth of Norris Run, N.W. Montgomery Co., July 1981 (81-Bc-1), (NR, U); on **6** at Claytor Lake S.P., Pulaski, June 1989 (89-8); stages II, III, on **6** in same area, Sept. 1991 (92-6); on **6** on W. bank of New R., 1.5 mi above Pembroke, Giles Co., Aug. 13, 1994 (94-30). These are (NR, U) for **6**.

Ustilago bullata Berk. in Hook., loose smut, was collected on **3** in a forage testing nursery on the old Agronomy (Kipps) Farm, VPI & SU, Blacksburg, Montgomery Co., Oct. 17, 1957. Although Farr et al. (1989) give a long list for this fungus on *Bromus* spp., there are no citations for Virginia. (NR, V).

Deuteromycotina - Hyphomycetes:

Bipolaris sorokiniana (Sacc.) Shoem., causing leaf spot on **8** was collected at Lovers Leap Overlook, U.S. 58, Patrick Co., May 23, 1993 (93-7). It has been found in Virginia on **3** but not on **8**, according to Farr et al. (1989). (NR, V).

Drechslera bromi (Died.) Shoem., leaf spot of brome grasses, has been collected on **3** at the old Agronomy (Kipps) Farm, VPI & SU, Montgomery Co., May 31, 1956 and Aug. 15, 1960 (56-Bi-1), and July 10, 1985 (85-Bi-2) (NR, V); on **6** along Rt. 860, near Endicott, Franklin Co., July 9, 1989 (89-46) (NR, U); on **7** near Graysontown, Pulaski Co., July 11, 1990 (90-26), near the Rt. 613 bridge across Little R., Snowville, Montgomery Co., July 11, 1990 (90-29). (NR, U).

Periconia atra Corda appeared on incubated dead stems of **1** collected at Eggleston, Giles Co., Nov. 15, 1981 (81-Bc-2). (NR, U). This species is not listed by Farr et al. (1989).

*P. macrospinos*a Lefebvre & Johnson appeared on incubated leaves of **7** collected at the Little R. bridge, Rt. 613, Snowville, Montgomery Co., June 11, 1990 (90-29).

Rhynchosporium secalis (Oudem.) J. J. Davis, causing scald, was collected on **3** opposite Hethwood Shopping Center, Prices Fork Rd., Montgomery Co., June 26, 1982 (82-Bi-1). It is common on **3** in Montgomery and surrounding counties but we have only a single collection. East of the Mississippi R., it is reported only from New Hampshire (Farr et al., 1989). (NR, V).

Spermospora subulata (R. Sprague) R. Sprague, was collected at the Glade Rd. Plant Pathology field plot area, Montgomery Co., on **3**, June 14, 1994 (94-7). Although it colonizes other *Bromus* spp., it is not previously reported on **3** (Farr et al., 1989). (NR, U).

Deuteromycotina - Hyphomycetes:

Ascochyta agropyri-repentis (R. Sprague) Punithalingham, described by Sprague as *Apiocarpella agropyri* (Sprague, 1950), was collected on **6** on Rt. 860, S. slope of the Blue Ridge, Franklin Co., July 9, 1989 (89-46). It may not belong in *Apiocarpella*

as stated by Sutton (1980), but neither is it typical of *Ascochyta*. Three-celled conidia are frequent and in two-celled conidia, the septum is nearer the basal tip. (NR, U).

Ascochyta sorghi Sacc., associated with leaf spots, was collected on 2 at the old Horticulture Farm, V.P.I. & S.U. (now The Market Place Shopping Center), Montgomery Co., June 15, 1982 (82-Bco-1); on Gap Mt., 1.5 mi. W. of U.S. 460, Montgomery Co., June 14, 1994; on Brush Mt., in N.W. corner of Roanoke Co., June 24, 1994 (94-16); on 4 at The Market Place, June 15, 1982 (82-Bj-1); at Franklin St. and N.S. Rwy., Christiansburg, Montgomery Co.; near Graysontown, Pulaski Co., June 11, 1990 (90-27); at the Little R. bridge on Rt. 613, Montgomery Co., June 11, 1990 (90-30); near the superintendent's house, Claytor Lake S.P., Pulaski, May 30, 1991 (91-25); along N.S. Rwy., 1.5 mi. W. of Whitethorne, Montgomery Co., June 6, 1995 (95-17); on 6, S. slope of Blue Ridge, Rt. 860, near Endicott, Franklin Co., July 9, 1989 (89-46); on Rt. 712, Ellett, Montgomery Co., June 6, 1990 (90-22); on 7 near Graysontown, Pulaski Co., June 11, 1990 (90-26); at Little R. bridge on Rt. 613, Montgomery Co., June 11, 1990 (90-29); on Rt. 700, 1 mi. below Mt. Lake, Giles Co., May 26, 1991 (91-16); on 8 at the old Agronomy (Kipps) Farm, June, 1982 (82-Bt-1). All collections on 2, 4, 8 are NR, V. All collections on 6, 7 are NR, U. The fungus appears to be a common parasite, causing leaf spots on *Bromus* spp. in the region around Blacksburg.

Colletotrichum graminicola (Ces.) G. W. Wils., the cause of anthracnose, was collected on 1 on Rt. 708, in N.W. Montgomery Co., July 1981 (81-Bc-1), (NR, U); on 3 on the old Agronomy (Kipps) Farm, Montgomery Co., July 3, 1984 (84-Bi-1), (NR, V); on 4 near Graysontown, Pulaski Co., June 11, 1990, (90-27), (NR, U); on 6, S. slope of Blue Ridge on Rt. 860, Franklin Co., July 9, 1989 (89-46); and at Ellett on Rt. 712, Montgomery Co., June 6, 1990 (90-22), (NR, V); on 7 at 607 Lucas Dr., Blacksburg, Montgomery Co., July 16, 1990 (90-54), (NR, U). This fungus is sometimes pathogenic but it is difficult to tell whether it caused disease or was saprophytic. Since it is so easily detected, it is surprising that it has not been found on more species than are listed by Farr et al. (1989).

Phaeoseptoria festucae var. *muhlenbergia* R. Sprague ex Punithalingham was found on blades collected on 2 at the Glade Rd., Plant Pathology field plot area, Montgomery Co., June 14, 1994 (94-7). Several *Phaeoseptoria* spp. have been found on grasses but only *P. aira* has been reported on a brome grass and that from Alaska (Farr et al., 1989). (NR, U).

Phloeospora graminearum R. Sprague & Hardison was collected on 4 at Ellett, Rt. 712, Montgomery Co., June 6, 1990 (90-23), and near Graysontown, Pulaski Co., June 11, 1990 (90-27), (NR, U); on 7 also at Ellett on Rt 712, June 6, 1990 (90-24), and near Graysontown, Pulaski Co., June 11, 1990 (90-26). (NR, U). No *Phloeospora* spp. are reported on *Bromus* spp. by Farr et al. (1989).

Stagonospora bromi Smith & Ramsb., causing a purple-brown leaf spot, was collected on 3 at the old Agronomy (Kipps) Farm, Montgomery Co., June 1955 (55-Bi-1). (NR, V).

S. montagnei Cast. & Germano, (= *S. graminella* Sacc.), associated with leaf spots on 8 was collected at the Lovers Leap Overlook on U.S. 58, Patrick Co., May 23, 1993, (93-7). (NR, U).

Deuteromycotina - other:

Rhizoctonia solani Kuehn, causing sharp eyespot, was collected on 6 on Rt. 712, Ellett, Montgomery Co., June 6, 1990 (90-22). (NR, U).

Calamagrostis spp., reed grass

We have made no collections of *Calamagrostis* in Virginia. However, Farr et al. (1989) report B - *Ustilago striiformis* (Westend.) Neissl as occurring on *C. scribneri* Beal in Virginia; this grass is known only from Washington, Oregon, and Rocky Mountain states. The origin of this questionable report is Fischer (1953).

Cenchrus spp., sandbur

No collections have been made from *Cenchrus* spp.; however, Farr et al. (1989) report A - *Balansia claviceps* Speg., inflorescence blight on *C. echinatus* L. in Virginia where the grass is not known to occur. More than likely, the host was *C. pauciflorus* Benth. (= *C. longispinus* (Hack.) Fern.), which is widespread in Virginia (Roane, 1991).

Chasmanthium spp., wild oats

This genus includes grasses formerly in the genus *Uniola*. No fungi are listed for Virginia in this genus by Farr et al. (1989). We will list our collections under *Uniola*.

Chloris verticillata Nutt., windmill grass

The fungi listed below came from a colony of windmill grass growing in traffic islands at Franklin Rd., and Avenham Ave., Roanoke, collected Aug. 17, 1994.

Ascomycotina:

Leptosphaerulina trifolii (Rost.) Petr., was fruiting on freshly wilted leaves. Although considered primarily as a pathogen of forage legumes, this fungus also colonizes several grass species. Ascospores were muriform, 29-37 X 13-19 μ m and were produced in broadly ovate to irregularly saccate asci measuring 85-90 X 50-60 μ m (95-35) (see Graham & Luttrell, 1961). (NR, U).

Basidiomycotina:

Ustilago chloridicola Henn., inflorescence smut. This fungus is reported to be only in California by Farr et al. (1989). (NR, EU).

Deuteromycotina - Hyphomycetes:

Bipolaris specifera (Bainier) Subram. fruited quickly on incubated leaves (94-35). (NR, U).

B. zeicola Stout also fruited quickly on incubated leaves (94-35). (NR, U).

Nigrospora sphaerica (Sacc.) Mason was present on newly wilted leaves (94-35). (NR, U).

Cinna arundinacea L., stout woodreed

Ascomycotina:

Phyllachora graminis (Pers.) Fuckel, tar spot, was collected at Gloucester Court House, Aug. 8, 1993 (93-16). It has been known from Virginia for many years (Sprague, 1950).

Basidiomycotina:

Puccinia recondita Roberge ex Desmaz., II, was also collected at Gloucester C.H. (93-16). (NR, V).

Deuteromycotina - Coelomycetes:

Colletotrichum graminicola (Ces.) G. W. Wils., causing anthracnose, was collected at the lake shore, along Va. 16, Hungry Mother S.P., Smyth Co., Sept. 1, 1989 (89-35). (NR, U).

Deuteromycotina - Hyphomycetes

Nigrospora sphaerica (Sacc.) Mason, appeared quickly on incubated leaves collected with *C. graminicola* above (89-35). (NR, U).

In addition, Farr et al. (1989) list A - *Epichloe typhina* (Pers.:Fr.) Tul., and B - *Puccinia graminis* Pers. as occurring in Virginia.

Cinna latifolia (Trevir) Griseb., drooping woodreed

Ascomycotina:

Phaeosphaeria cinnae Shoem. & Babcock, was collected along a stream beside the Blue Ridge Parkway between Rocky Knob and Mabry Mill, Floyd Co., July 24, 1994 (94-21). (NR, U). Shoemaker & Babcock (1989) report specimens only from *C. arundinacea* in Ontario.

Cynodon dactylon (L.) Pers., Bermudagrass

Plasmodiophoromycetes:

Polymyxa graminis Ledingham was identified in roots of plants collected in Broadus Flats near U.S. 360, Hanover Co., April 7, 1982 (82-Cd-1), and Aug. 23, 1983 (83-Cd-1). This fungus is the vector for three cereal viruses in Virginia. (NR, V).

Basidiomycotina:

Ustilago cynodontis (Henn.) Henn. has been sent to the Plant Clinic at V.P.I. & S.U. several times. A specimen in the class files was received in July 1964; a specimen from Pittsylvania Co., was received in the Clinic June 20, 1991 (91-43). (NR, V).

Deuteromycotina - Hyphomycetes:

Acremonia verrucosa Tognini appeared on incubated leaves collected on the old Agronomy (Kipps) Farm, V.P.I. & S.U., Montgomery Co., Nov. 11, 1981 (81-Cd-1). The identity was established from the description and illustration given by Ellis (1971). (NR, U).

Bipolaris cynodontis (Marig.) Shoem., was the primary fungus in the collection above (81-Cd-1). Other collections are from Wingina, Nelson Co., Aug. 1, 1984 (84-Cd-1), Montgomery Tunnels, Montgomery Co., Sept. 12, 1989 (89-43) and July 22, 1995 (95-31). The fungus is common on Bermudagrass in this region throughout the growing season and has been known from Virginia for many years.

Deuteromycotina - Coelomycetes:

Amerisporium atrum (Fuckel) Höhn., appeared on incubated leaves collected at Montgomery Tunnels, Montgomery Co., July 22, 1995 (95-31). It is illustrated by von Arx (1981). (NR, U).

Ascochyta sorghi Sacc. was present on leaves in the collection above (95-31). (NR, U.).

Colletotrichum graminicola (Ces.) G. W. Wills. was also in the collection from Montgomery Tunnels (95-31). Surprisingly, it has not been reported on *Cynodon* in eastern states (NR, EU).

Dactylis glomerata L., orchardgrass

Mastigomycotina - Oomycetes:

Sclerospora graminicola (Sacc.) J. Schröt., appeared on one stem of *D. glomerata* in the backyard of our residence at 607 Lucas Dr., Blacksburg, Montgomery Co., July 12, 1995 (95-28). The plant had yellowed upper leaves and elongated spikelet structures. Lemmas were elongated up to 5 cm and were modified to have sheaths and blades, complete with ligules and collars. Sporangiophores and sporangia were present on some spikelets; a photograph is available. Spores are papillate, ovoid to globose, measuring 11-12 X 10-11 μm . Since *Sclerophthora macrospora* (Sacc.) Thir., Shaw, and Naras., was the suspected fungus, a search was made for oospores; none was found. Sporangiospores measured in the low range for *S. graminicola* given by Weston (1924), i.e., 12-34 X 10-20 μm much smaller than sporangiospores of *S. macrospora*, i.e., 60-70 X 38-52 μm (Sprague, 1950). A disease known as yellow tufts occurs in turf grasses in Virginia and is attributed to *S. macrospora*, but its presence has not been published. Even though the symptoms suggest to us that *S. macrospora* is the probable cause, no flooding occurred where the specimen was collected. Flooding is usually a prerequisite for infection by *S. macrospora*. Therefore, because the fungus has small sporangia and lacks oospores, we have assigned it to *S. graminicola*. (NR, U).

Ascomycotina:

Claviceps purpurea (Fr.:Fr.) Tul., the ergot fungus, has been collected at the old Agronomy Farm, Montgomery Co., July 1982 (82-Dg-2); on Gap Mt., off the forest service road 5 mi. W. of U.S. 460, Montgomery Co., July 10, 1983 (83-Dg-1); in the Roane backyard, Blacksburg, Montgomery Co., July 31, 1990 (90-74); on Rt. 619, Indian Valley, Floyd Co., July 4, 1991 (91-58), and at Dickey Ridge Recreation Center, Skyline Dr., Warren-Rappahannock Co. line, July 11, 1991 (91-62). Farr et al. (1989) list it as occurring in eastern states.

Erysiphe graminis DC. (now *Blumeria graminis* (DC.) E.O. Speer), causing powdery mildew, was collected on Gap Mt., 5 mi. W. of U.S. 460, Montgomery Co., July 3, 1982 (81-Dg-1). It is known from the eastern states (Farr et al., 1989).

Phaeosphaeria eustoma (Fuckel) L. Holm, occurred on leaves of plants 0.5 mi. W. of Whitethorne, Montgomery Co., June 9, 1991 (91-30). Shoemaker & Babcock (1989) list *D. glomerata* as a host in Canada. (NR, U).

Basidiomycotina:

Puccinia graminis Pers., stem rust, was collected at the Glade Rd., Plant Pathology plots Nov. 28, 1960 (60-Dg-1), Nov. 19, 1983 (83-Dg-2); at the Kipps farm Oct. 12, 1981 (81-Dg-1), Sept. 16, 1982 (82-Dg-4), and Sept. 25, 1982 (82-Dg-3); at the Roane yard July 31, 1990 (90-5) and at Lucas and Dickerson Dr., Blacksburg, July 1993 (93-24); the foregoing are from Montgomery Co.; at Claytor Lake S.P., Pulaski Co.,

Oct. 3, 1982 (82-Dg-6). The fungus has been known on this host in Virginia for many years.

Uromyces dactylidis Oth, stages II, III, rust, was collected at Williamsburg, James City Co., 1948 (48-Dg-1); on the old Agronomy (Kipps) Farm, Montgomery Co., Sept. 27, 1962; and at the Glade Rd. Plant Pathology plots, Aug. 20, 1957, Montgomery Co., (57-Dg-1), at Rt. 700 and Sinking Ck., Giles Co., Nov. 14, 1981 (81-Dg-5); on the V.P.I. & S.U. Horticulture Farm (now The Market Place) Montgomery Co., July 12, 1989 (89-Dg-4); at Claytor Lake S.P., Pulaski Co., June 17, 1990 (90-36); at in the Roane backyard, Montgomery Co., July 1993 (93-24).

Ustilago striiformis (Westend.) Niessl, stripe smut, was collected on the Kipps farm, Montgomery Co., May 31, 1955 (55-Dg-1). Fischer (1953) lists it as from Virginia and eastern states.

Deuteromycetes - Hyphomycetes:

Arthrotrys oligospora Fresen. appeared on incubated leaves having scald-like lesions collected at the old Horticulture Farm (The Market Place), Montgomery Co., July 18, 1989 (89-Dg-5). The fungus is illustrated by Ellis & Ellis (1985). No doubt it is a saprophyte. (NR, U).

Bipolaris sorokiniana (Sacc.) Shoem. occurred on leaves collected 0.5 mi. W. of Whitethorne, Montgomery Co., June 9, 1991 (91-39). The fungus occurred on nearby barley. (NR, U).

Cercosporidium graminis (Fuckel) Deighton was collected at Williamsburg, James City Co., June 1948 (48-Dg-1); the Glade Rd. Plant Pathology plots, Montgomery Co., Sept. 1955 (83-Dg-2) and May 25, 1990 (90-11); at the old Horticulture Farm (The Market Place), Montgomery Co., July 12, 1989 (89-Dg-4); at Lucas and Dickerson Dr., Blacksburg, Montgomery Co., July 1993 (93-24); from County Agent, Hanover Co., Sept. 2, 1994 (Plant Clinic 94-1385); at Roane residence, Lucas Dr., Blacksburg, Montgomery Co., July 17, 1995 (95-29).

Drechslera dactylidis Shoem., causing leaf spot, was sent to the Plant Clinic from Hanover Co., May 1, 1989 (89-Dg-1). Orchardgrass is not commonly grown in eastern Virginia; the fungus was believed to cause the grass to die out. (NR, V).

Fusarium acuminatum Ellis & Everh. occurred on leaves collected at the Kipps farm Sept. 16, 1982 (82-Dg-4). Although it is listed as a root colonizing fungus (Farr et al., 1989), it has been found on leaves of several grasses. (NR, EU).

Mastigosporium rubricosum (Dearn. & Barth.) Nannf., causing eyespot, was collected on Rt. 613 at the N. end of Mt. Lake, Giles Co., June 24, 1990 (90-45). (NR, V).

Nigrospora sphaerica (Sacc.) Mason, appeared on leaves of plants sent to the Plant Clinic from Hanover Co., Sept. 2, 1994 (94-46). The fungus often appears on incubated leaves of various grasses and may be a saprophyte. (NR, U).

Rhynchosporium orthosporum Caldwell causing scald, has been collected on the S. slope of Gap Mt., 5 mi W. of U.S. 460, Montgomery Co., July 3, 1982 (82-Dg-1); at the old Horticulture Farm (The Market Place), Montgomery Co., Sept. 19, 1989 (89-48); at the lake shore, Claytor Lake S.P., Pulaski Co., June 17, 1990 (90-36); in Roane's yard, Blacksburg, Montgomery Co., July 1, 1994 (94-9) and July 17, 1995 (95-29); at Groundhog Mt., Blue Ridge Pkwy., Carroll Co., June 18, 1995 (95-23). (NR, V).

Deuteromycotina - Coelomycetes:

Ascochyta graminea (Sacc.) R. Sprague & Johnson, associated with leaf spots, was collected 0.5 mi. W. of Whitethorne, Montgomery Co., June 9, 1991 (91-30). Spores measured 14-17 X 4-5 μ m. (NR, U).

A. sorghi Sacc., associated with leaf spots, was collected on Rt. 613 at the ridge overlooking Stoney Ck. Valley (= then the junction with Appalachian Tr.), Giles Co., June 24, 1990 (90-45). Spores measured 12-19 X 1.5-3.0 μ m on the average, slenderer than those of *A. graminea*. (NR, V).

Colletotrichum graminicola (Ces.) G. W. Wils., causing anthracnose, has been found in many collections. In Montgomery Co., at several locations in Blacksburg, Oct. 1981 (81-Dg-2); Oct. 12, 1981 (81-Dg-4); Nov. 11, 1983 (83-Dg-2); May 30, 1990 (90-16); July 1993 (93-24); on the old Horticulture Farm (The Market Place) July 12, 1989 (89-Dg-4); at Camp Fincastle, Botetourt Co., Oct. 29, 1989 (89-67); at Rustburg, Campbell Co., July 13, 1993 (93-15); at Groundhog Mt., Blue Ridge Pkwy., Carroll Co., June 18, 1995 (95-23); at Delaplane, Fauquier Co. (Plant Clinic no. 89-2318), Aug. 30, 1989 (89-Dg-6); on Rt. 613 at N. end of Mt. Lake, Giles Co. June 24, 1990 and May 26, 1991 (90-45, 91-20); along the lake shore, Claytor Lake S.P., Pulaski Co., Oct. 3, 1982, July 14, 1989, and June 17, 1990 (82-Dg-6, 89-8, 90-36). The fungus has been known on *D. glomerata* in Virginia for many years. No doubt it can be found wherever the grass grows.

Dilophospora alopecuri (Fr.) Fr., causing twist, was found at the eastern continental divide, old Horticulture Farm (The Market Place), Montgomery Co., June 26, 1989 (89-Dg-3). Williams (1964) reported its occurrence in Virginia but did not list a collection site.

Pestalotiopsis disseminata (Thuem.) Stayaert. A fungus fitting the description of *Pestalotia disseminata* Thuem. as described by Guba (1961, p. 139), appeared on incubated leaves collected on N. Main St. near U.S. 460, Blacksburg, Montgomery Co., May 30, 1990 (90-16). It appeared to be saprophytic; no representatives of this genus are reported on grasses (Farr et al., 1989). (NR, U).

Phoma sorghina (Sacc.) Boerema., Doren., and Van Kest., occurred on leaves collected 0.5 mi. W. of Whitethorne, Montgomery Co., June 9, 1991 (91-39). Spores measured 4-6 X 2.3 μ m thus fitting well within the dimensions given by Sprague (1950). (NR, U).

Sphaerellopsis filum (Biv.-Bern. ex. Fr.) Sutton (= *Darluca filum*) is a parasite of rusts. It was found in *Puccinia graminis* on *D. glomerata* collected at the Glade Rd. Plant Pathology plots, Blacksburg, Montgomery Co., Nov. 28, 1960 (see above, 60-Dg-1). (NR, U).

Stagonospora arenaria (Sacc.) Sacc., causing purple-brown leaf blotch, has been collected from the Rocky Mount area, Franklin Co., Apr. 30, 1990 (90-12); Rt. 770 and Sinking Ck., Giles Co., June 12, 1993 (93-10); and the following sites in Montgomery Co.: S. slope Gap Mt., 5 mi W. of U.S. 460, July 3, 1982 (82-Dg-1); the Kipps farm, Sept. 16, 1982 (82-Dg-5); Glade Rd. Plant Pathology plots, Nov. 9, 1983 (83-Dg-2); near Pandapas Pond, June 9, 1985 (85-Dg-1); on the old Horticulture Farm (The Market Place) July 12, 1989 (89-Dg-4); Roane's backyard, Blacksburg, July 1990 (91-36); 0.5 mi. W. of Whitethorne, June 9, 1991 (91-39). Spores of *S. arenaria*

measure 25-60 X 2.5-5.0 μm and are nearly cylindrical, not constricted at the septa; compare with *S. maculata* below. (NR, V).

S. maculata Castallani & Germano, purple leaf spot, is characterized by shorter, wider, boat-shaped spores, constricted at the septa, measuring 27-40 X 4.8-6.5 μm . Specimens were collected at Rustburg, Campbell Co., July 13, 1993 (93-15); at Groundhog Mt., Blue Ridge Pkwy., Carroll Co., June 18, 1995 (95-23); in Roane's yard, Blacksburg, Montgomery Co., Oct. 1981, July 12, 1995, and July 17, 1995 (81-Dg-1, 95-28, 95-29); along the lake shore, Claytor Lake S.P., Pulaski Co., June 17, 1990 (90-36); on Brush Mt. near the Audie Murphy monument, Roanoke Co., June 14, 1994 (94-10). The two *Stagnospora* spp. sometimes occur in mixed infections; both are widespread in Virginia. (NR, V).

Deuteromycotina - other:

Rhizoctonia solani Kuehn, causing foliage blight, was collected along the lake shore, Claytor Lake S.P., Pulaski Co., July 14, 1989 (89-3). According to Farr et al. (1989), Drake (1958) reported *R. solani* on *D. glomerata*. Drake said that *R. solani* occurred on *Lotus* cvs. planted in mixed stands with *D. glomerata*. Thus, this is the first report of *R. solani* on *D. glomerata* in Virginia. (NR, V).

Danthonia, oatgrass

Three species of *Danthonia* occur in Virginia; we have identified fungi occurring on *D. spicata* (L.) Beauv. ex. Roem. & Schult., and *D. compressa* Aust.

Ascomycotina:

Atkinsonella hypoxylon (Peck) Diehl, black choke, was found on *D. spicata* along the hiking trail in woods behind the swimming area, Claytor Lake S.P., Pulaski Co., June 21, 1991 (91-52), and on *D. compressa* along the Blue Ridge Pkwy., between Rocky Knob and Mabry Mill, Patrick Co., June 18, 1995 (95-22). Diehl (1950) cites specimens in herbaria from Virginia as early as 1918 but does not state which species was the host. The fungus is generally distributed in eastern states on *D. compressa* and *D. spicata* (Farr et al., 1989).

Basidiomycotina:

Ustilago residua G. P. Clinton, panicle smut, was collected on *D. spicata* along the War Spur Trail off Rt. 613 (Salt Sulphur Tnpk.), Giles Co., June 22, 1980, and May 26, 1991 (80-Ds-1, 91-18); and on the S. slope of Gap Mt., 1.5 mi. W. of U.S. 460, Montgomery Co., May 31, 1989 (89-76). It was collected on *D. compressa* on the War Spur Trail June 24, 1990 (90-44). The fungus has long been known on *Danthonia* spp. in Virginia (Farr et al., 1989).

Deuteromycotina - Hyphomycetes:

Curvularia geniculata (Tracy & Earle) Boedijn, leaf mold, was collected on *D. spicata* at White Top Mt., Smyth-Grayson Co. line, Aug. 31, 1989 (89-69); and on S. slope of Gap Mt., 5 mi. W. of U.S. 460, Montgomery Co., July 3, 1982 (82-Ds-2). (NR, U).

Drechslera campanulata (Lév.) Sutton, causing leaf spot, was collected on *D. spicata* along Forest Service road 630 off Rt. 621, N.E. Montgomery Co., June 9, 1991 (91-40). (NR, U).

Microdochium bolleyi (R. Sprague) DeHoog & Hermanides-Nijhot, was found associated with bright tan leaf spots in *D. spicata* plants collected on the south slope of Gap Mt., Montgomery Co., 5 mi. W. of U.S. 460 on July 3, 1982 and 1 mi. W. of U.S. 460, May 31, 1989 (82-Ds-1, 89-Ds-1). (NR, EU).

Spermospora subulata (R. Sprague) R. Sprague occurred on incubated leaves of *D. compressa* collected on the Blue Ridge Pkwy., Patrick Co., June 18, 1995 (95-22). (NR, U).

Volutella ciliata (Alb. & Schwein.) Fr., produced scattered sporodochia on incubated leaves of *D. spicata* collected on Forest Service road 630 off Rt. 621, N.E. Montgomery Co., June 9, 1991 (91-40). (NR, U). See Ellis & Ellis (1985).

Deuteromycotina - Coelomycetes

Amerosporium atrum (Fuckel) Höhn., appeared on incubated leaves of *D. spicata* collected along the Forest Service road, S. slope of Gap Mt., 5 mi. W. of U.S. 460, Montgomery Co., July 3, 1982 (82-Ds-2). (NR, U).

Colletotrichum graminicola (Ces.) G. W. Wils., anthracnose, was collected on *D. spicata* along the Forest Service road 630 off Rt. 631, N.E. Montgomery Co., June 9, 1991 (91-40). It is reported only from N.W. United States (Farr et al., 1989). (NR, EU). It also occurred on *D. compressa* along the Blue Ridge Pkwy, Patrick Co., June 18, 1995 (95-22). (NR, EU).

Phomatospora dinemasporium J. Webster, occurred on incubated leaves of *D. compressa* from the Blue Ridge Pkwy. site above, collected June 18, 1995 (95-22). (NR, U).

Pseudoseptoria donacis (Pass.) Sutton, causing halo spot, occurred on leaves of *D. spicata* collected 1 mi. W. of U.S. 460 on S. slope of Gap Mt., Montgomery Co., July 3, 1982 (82-Ds-2). Spores were lunate, measuring 15-29 X 2.5 μ m. Sprague (1950) describes the variability of spores from different localities and hosts. Most records are from N.W. United States; our collection is rare for eastern states. (NR, U).

Stagonospora simplicior Sacc. & Briard or *S. brachyelytri* Greene was collected on *D. spicata*. Spores were cylindrical to slightly tapered, with rounded ends, sometimes slightly constricted at the three septa, cells vacuolate as on *S. simplicior*, measuring 22-25 X 6-7 μ m (very uniform). Spores of *S. simplicior* are broader and longer, 28-38 X 8-9 μ m; those of *S. brachyelytri* are 13-33 X 5-7 μ m (Sprague, 1950). We tentatively assign our collection to *S. brachyelytri*. *S. subseriata* (Desmaz.) Sacc. is known on a western *Danthonia* but it has boat-shaped spores. In any case, our collection made June 9, 1991, on Forest Service road 630, off Rt. 631, N.E. Montgomery Co. is a NR, U.

In addition, Farr et al. (1989) list A - *Epichloe typhina* (Pers:Fr.) Tul, causing choke, on *D. compressa* in Virginia and on *D. spicata* in eastern U.S.

Dichanthelium spp., panic grasses

Dichanthelium (formerly subgenus of *Panicum*) is represented by 20 species in Virginia (Roane, 1991). Many of those listed by Hitchcock & Chase (1950) have been reduced to synonyms by Gould, Clark, & Shaw (Gould and Clark, 1983). We have identified fungi on eight former *Panicum* spp., now regarded as *Dichanthelium* spp. In the discussion, species will be referred to by number; for synonyms, see Roane (1991); in Farr et al. (1989), see under *Panicum*.

1. *D. acuminatum* (Swartz.) Gould & Clark, southern panic.
2. *D. boscii* (Poir.) Gould & Clark, no common name.
3. *D. clandestinum* (L.) Gould, deer tongue.
4. *D. commutatum* (Schult.) Gould & Clark, variable panic.
5. *D. depauperatum* (Muhl.) Gould, starved panic.
6. *D. dichotomum* (L.) Gould, forking panic.
7. *D. laxiflorum* (Lam.) Gould, loose-flowered panic.

Ascomycotina:

Mycosphaerella allicina (Fr.:Fr.) Vestergr. occurred on 6 in the Audie Murphy Monument area, Brush Mt., near Craig-Roanoke Co. line, June 24, 1994 (94-14). Ascospores were 1-septate, constricted, cells unequal, hyaline, 17-19 X 6-7 μ m. See Ellis & Ellis, p. 464 (1985). (NR, U).

Paraphaeosphaeria michotii (Westend.) O. Eriksson, was collected on leaves of 1. The fungus was associated with bright tan lesions on leaves collected along the lake shore at Claytor Lake S.P., Pulaski Co., July 14, 1989 (89-4). See Ellis & Ellis pp. 464, 540 (1985). (NR, U).

Phyllachora punctum (Schwein.) Orton & Stevens has been collected on 1 along the lake shore, Claytor Lake S.P., Pulaski Co., July 14, 1989 (89-4) (NR, U); on 2 along the lake-ridge trail, Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-37); and along Mt. Rogers Recreation Area Hdqtrs. nature trail Va. 16, Smyth Co., Aug. 14, 1994 (94-28), (NR, U); on 3 at Little R. bridge on Rt. 613, Montgomery Co., Aug. 4, 1989 (89-22) and along Va. 8 & Dodds Ck., S. of Floyd, Oct. 3, 1994 (95-9); on 4 along lake-ridge trail, Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-39), (NR, U). In addition, *D. depauperatum* and *D. sphaerocarpon* (Ell.) Gould are listed by Farr et al. (1989) as hosts of this fungus in Virginia.

Basidiomycotina:

A rust fungus occurred on 2 at Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-38). No teliospores were present. Specimens were sent to J. F. Hennen of the Arthur (Rust) Herbarium, Purdue Univ. but he could not make a positive identification. *Puccinia emaculata* Schwein. and *Uromyces graminicola* Burrill are reported to occur in Virginia on unidentified *Panicum* spp. (Farr et al., 1989) which in the revised genus may include *Dichanthelium* spp.

Deuteromycotina - Hyphomycetes:

Exserohilum monoceras (Rechts.) Leonard & Suggs, was associated with elliptical, zonate, brown lesions on 3 collected on the lake shore, Claytor Lake S.P., Pulaski Co., Aug. 11, 1989 (89-33). (NR, U).

Microdochium bolleyi (R. Sprague) DeHoog & Herm.-Nijhof, associated with circular, tan leaf spots, was collected on 2, 4, 5 in a small area off the Gap Mt.-Poverty Ck. Forest Service Rd. 1.5 mi. W. of U.S. 460, Montgomery Co., May 28-31, 1989 (89-Db-1, 89-De-1, 89-Dd-1); and on 6 Forest Service Rd. 630 of Rt. 621, N.E. Montgomery Co., June 9, 1991 (91-33). (NR, U on all hosts).

Nigrospora sphaerica (Sacc.) Mason, was present on dead culms of living plants of 1 collected on the old Horticulture Farm (The Market Place), Montgomery Co., Sept. 19, 1989 (89-49). (NR, EU).

Pyricularia grisea (Cooke) Sacc., associated with bright tan leaf spots on *1* was collected at the lake shore, Claytor Lake S.P., Pulaski Co., July 14, 1989 (89-4). (NR, U).

Ramularia graminicola Peck, was associated with leaf spots on *2* collected on the lake-ridge trail, Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-37); and was associated with linear to elliptical leaf spots on *3*, collected on the old Horticulture Farm (The Market Place), Montgomery Co., June 21, 1989 (89-5). The description of this fungus is given by Sprague (1950). Peck's (1891) original description was not available. Although our collection satisfactorily fits *Ramularia*, the specific epithet may be questioned; however, this genus has not been found previously on *2* and *3*. (NR, U).

Tetraploa aristata Berk. & Broome was associated with leaf streaks on *3*, collected on the old Horticulture Farm (The Market Place), Montgomery Co., Oct. 11, 1989 (89-54). (NR, U).

Deuteromycotina - Coelomycetes:

Ascochyta sorghi Sacc., was collected on *3* by Diane Reaver along Sinking Ck. at the end of Rt. 770, 4 mi. E. of Newport, Giles Co., July 13, 1990 (90-53). (NR, U).

Chaetoseptoria sp., associated with small brown spots occurred on *7*, collected at Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-77). Pycnidia at first submerged, erumpent, smooth, later becoming nearly superficial and crowned with 10 or more brown, acute, 2-5-septate setae, up to 160 μm long. Pycnidiospores measured 60-70 X 1.5-2.0 μm , were 2-5-septate (mostly 3-sep.). A second collection on *1* came from the old Horticulture Farm (The Market Place), Montgomery Co., Sept. 19, 1989 (89-49). Pycnidia measured only up to 45 μm and spores were 45-60 X 1 μm smaller, than in the Smyth Co. collection. Only *C. vignae* on *Vigna unguiculata* (L.) Walp. is listed by Farr et al. (1989). This fungus genus is not listed on grass hosts. (NR, U).

Colletotrichum graminicola (Ces.) G. W. Wils., causing anthracnose, was collected on *2* at Adner, Gloucester Co., Sept. 24, 1989 (89-51). (NR, U).

Phomatospora dinemasporium J. Webster, occurred on *7* collected at Hungry Mother S.P., Smyth Co., Sept. 3, 1989 (89-77). (NR, U). This fungus is described and illustrated by Sutton (1980).

Phoma sorghina (Sacc.) Boerema, Doren., & Van Kesteren, with ellipsoid pycnidiospores measuring 3-9 X 2-3 μm was collected on *3* at the old Horticulture Farm (The Market Place), Montgomery Co., Oct. 11, 1989 (89-54). (NR, U).

Phyllosticta anthoxella R. Sprague, having bacillar-shaped, guttulate spores measuring 5-7 X 0.8-1.5 μm associated with linear stripes on overwintered culms of *3*, was collected at the lake shore, Claytor Lake S.P., Pulaski Co., Mar. 25, 1991 (91-4). The species from which this fungus was originally collected by Sprague (1950), *Anthoxanthum odoratum* L., was growing close to the stand of *3*. (NR, U).

Phyllosticta healdii R. Sprague, having biguttulate oval spores, measuring 11-15 X 3.5-5.0 μm was collected on *1* at the lake shore, Claytor Lake S.P., Pulaski Co., July 14, 1989 (89-4), (NR, EU); and on *6* near the Audie Murphy Monument on Brush Mt., N.W. Roanoke Co., June 24, 1994 (94-14). (NR, U). Sprague (1950) described *P. healdii* from *Panicum huahucae* Ashe, included by Gould & Clark (1983) in *I D. acuminatum* (Roane, 1991).

Septoria arechavaletae Wint. was collected on 6 on Forest Service Rd. 630 off Rt. 621, N.E. Montgomery Co., June 9, 1991 (91-33). Spores were 3-8-septate, filiform-vermiform 50-100 X 1.0-1.2 μ m. Sprague (1946) questions the validity of this species and suggests it should be included in *S. tandilensis*. The only collection of *S. arechavaletae* to date was that of Fairchild on *Panicum capillare* L. in Virginia (Sprague 1946). We hesitatingly call our collection a NR, U.

S. tandilensis Speg., causing a leaf spot, was collected along the lake shore at Claytor Lake S.P., Pulaski Co. on 1 July 14, 1989, and on 3 Oct. 10, 1988. Pycnidia were very prevalent in lesions on leaves in the collections. (NR, V).

Stagonospora simplicior Sacc. & Briard, associated with elliptical leaf spots on 2 & 3 has been collected on 2 at Hungry Mother S.P., Smyth Co., Sept. 3, 1989, and at Adner, Gloucester Co., Sept. 24, 1989. (NR, U). It was collected on 3 on Gap Mt., 1 mi. W. of U.S. 460, Montgomery Co., July 1985; at Rt. 613 and Little R., Montgomery Co., Aug. 4, 1989; on the lake-ridge trail, Hungry Mother S.P., Smyth Co., Sept. 3, 1989; and on the lake shore Claytor Lake S.P., on overwintered stems, Mar. 25, 1991. (NR, U).

Digitaria spp., crabgrasses

Roane (1991) lists five species of *Digitaria* in Virginia; we have collected and identified fungi on only two species.

1. *D. ischaemum* (Schreb.) Schreb. ex. Muhl.
2. *D. sanguinalis* (L.) Scop.

Ascomycotina:

Pleospora sp. or *Pyrenophora* sp. We have found an ascomycetous fungus with sunken to erumpent, smooth pseudothecia, bearing cylindric to slightly saccate bitunicate asci, and muriform, dark brown, ascospores, with 3-5 transverse septa, constricted at the septa, blunt on one end, more tapering on other, measuring 29-36 X 11-17 μ m, occurring on frosted leaves of 1 at Camp Fincastle, Botetourt Co., Oct. 29, 1989. More careful work is needed before we can make a definite determination. Nothing approaching *Pyrenophora* or *Pleospora* has been reported on crabgrass.

Basidiomycotina:

Ustilago syntherismae (Schwein.) Peck, has been identified on 1 from Augusta Co., (V.P.I. & S.U. Pl. Clinic no. 82-2794), Oct. 6, 1982 (82-Di-2); from Collinsville at U.S. 220 (Business) and Rt. 732, Henry Co., Sept. 25, 1994; from Christiansburg, Montgomery Co., Sept. 28, 1982 (82-Di-1); on 2 from Roane's yard, Blacksburg, Montgomery Co., Oct. 12, 1981 (81-Ds-1); on 1, Sept. 16, 1995 (95-36) and 2 Sept. 8, 1991, both in the cabin area, Claytor Lake S.P., Pulaski Co. There are previous reports on 1 and 2 and also on *D. filiformis* (L.) Koel. from Virginia (Farr et al., 1989). Although the hosts flower from June to October, smutted racemes do not appear before late August in Virginia.

Deuteromycotina - Hyphomycetes:

Curvularia intermedia Boedijn appeared on incubated leaves of 1 collected at U.S. 220 & Rt. 732, Collinsville, Henry Co., Sept. 25, 1994 (94-58). Spores were asymmetrical, 3-septate, middle septum median, having an inconspicuous hilum, and measuring 25-32 X 15-18 μ m. The fungus is illustrated by Ellis (1971). (NR, U).

Curvularia trifolii (Kauf.) Boedijn was collected on frost-killed leaves of *1* from Camp Fincastle, Botetourt Co., Oct. 29, 1989. Like *C. intermedia*, *C. trifolii* has 3-septate, asymmetrical spores, but the enlarged second cell forces the middle septum below the median. There is a protruding hilum. (NR, EU).

Pyricularia grisea (Cooke) Sacc. occurs commonly on *2* throughout Virginia. Collections have been made from Charlotte, King & Queen, Montgomery, and Pulaski Cos. beginning in early August. Oddly, the fungus occurs on *1* & *2* throughout their ranges, but we have no records of it on *1*.

Tetraploa aristata Berk. & Broome was collected on *2* at Broadus Flats, Hanover Co., Aug. 23, 1983. (NR, U).

Deuteromycotina - Coelomycetes:

Collectotrichum graminicola (Ces.) G. W. Wils., was collected on *1* near the woods behind the marina at Claytor Lake S.P., Pulaski Co., Oct. 30, 1995 (95-49). (NR, V).

DISCUSSION AND SUMMARY

We have listed fungi on Virginia grass genera *Aegilops* through *Digitaria* (A through D). We have made no effort to determine whether the fungus in an association is saprophytic or parasitic. When we incubated plant parts, *Alternaria*, *Cladosporium*, *Epicoccum*, and *Penicillium* invariably appeared. We regarded them as saprophytes and ignored them. The fungi we reported seemed to be associated with a symptom or disintegration of the host we collected. Despite our position, we recognize that some of our reported fungi may be only saprophytes but their frequent association with different components of the incubated material prompted us to accept them as a regularly occurring partner. Their presence is recognized, and they are regarded as elements of our mycoflora. Many associations are reported as new for the United States (NR, U), for eastern United States (NR, EU), or for Virginia (NR, V). The large number of new records may be attributed to the fact that no one before us has collected extensively the fungus-grass associations occurring in Virginia.

ACKNOWLEDGEMENTS

We are grateful to Dr. L. D. Moore for availing to us the facilities and secretarial pool of the Department of Plant Pathology, Physiology and Weed Science. We are pleased to have this support as it allows us in our retirement to make original contributions to the natural history of Virginia. We are especially grateful to Judy Fielder for her patience in converting our scripted notes into publishable form.

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**Minutes of the May 22 1996 Meeting
of the Executive Committee
of the Academy Council
of the Virginia Academy of Science**

University Student Commons Alumni Association Board Room, Virginia
Commonwealth University, 2 pm, May 22, 1996

Members Present: Thomas O. Sitz (President), Elsa Q. Falls (Immediate Past President), R. Dean Decker (President-elect), Carolyn M. Conway (Vice President), Joseph W. Rudmin (Secretary), Arthur W. Burke, Jr. (Assistant Executive Secretary-Treasurer), Donald R. Cottingham (Director, Junior Academy of Science). Others Present: Darcy Mays (Incoming Treasurer), James Martin, (Editor of the Virginia Journal of Science), Larry Snedden, (photographer).

Members Absent: Greg Cook (Treasurer), Blanton Bruner (Executive Secretary Treasurer).

The meeting commenced at 2:10 pm.

1. Introductions: Participants introduced themselves.
2. The Agenda was adopted
3. The minutes of the November meeting were approved, and the minutes of the March meeting were approved subject to submitted corrections.
4. Officers' Reports
 - a. President, Tom Sitz

i. Future meeting sites: Tom reported receiving a letter from President Covington at Radford University inviting the Academy to hold the annual meeting there in the year 2000. Tom sent a response to him, with copies going to appropriate people at Radford and to Richard Brandt (Long Range Planning Committee Chair), suggesting Judy Niehaus as contact person and Local

Arrangements Chair. I plan to write John Casteen about holding the meeting in 2001 or 2002 at the University of Virginia. This will be done in consultation with Jim Murray, Ken Lawless, and Ertle Thompson, who are active Academy members there.

Tom asked when was the last time the Academy met at William and Mary. Dean Decker said that it was in 1975. There has not been a meeting there since, because the Academy has not felt welcomed there. Moreover, there are few active Academy members there. Art Burke said that since the W&M administration has since changed, they should be reconsidered as a meeting set. Dean Decker suggested Ronald Giese as a possible contact person on this question. Mary Washington was suggested as a possible site. Michael Bass would be an appropriate person to ask about this. Committee members were not certain of the date of the most recent meeting there, but felt that it was time to ask them again. We have

an invitation to return to VCU in the year 2003, which is well set. The years 2001 and 2002 still need to be settled.

The University of Richmond was mentioned as a very attractive site for the meetings, especially regarding the activities of the Junior Academy. However, there is currently a shortage of active Academy members there who would be willing to carry on the duties needed.

Christopher Newport, Virginia State, and Hampton University were also mentioned as possible sites.

ii. Teaching Creationism in the Public Schools: Tom Sitz said that a situation has arisen to which the Academy might wish to respond. The Superintendent of Public Instruction, William Boshier, has suggested that creationism might be given equal weight with evolution in teaching biology. Tom has asked Tom Teates, co-chair of the Science Education Committee, to look into this and perhaps coordinate a response with other science organizations in the state. Teates has suggested either reviving a previous statement on this which we used several years ago, or using a very good statement developed by the State Department of Education. He has nothing ready for this meeting however. Art Burke thought that such a statement might alienate more support than it garners. A statement from someone other than the Academy would carry a lot more weight. The AAAS might be consulted. Tom Sitz replied that they have a very good statement on this issue. Dean Decker suggested NABT--the National Association of Biology Teachers. Joe Rudmin thought that non-fundamentalist churches might be supportive. Dean Decker supported Art's position by noting that nothing further had developed from the statement. Art added that he thought that Boshier's statement was political rather than ideological, and Dean Decker said that he was a strong supporter of the Junior Academy program. The final consensus was that it would be best to do nothing at this time.

b. President-Elect, Dean Decker

i. The Current Meeting

Dean said that his major efforts in the meeting have been to procure judges. Of all the people who said they would come, there have been only two no-shows. In general the meeting has been going well.

Art Burke mentioned two people in particular, Ann and Preston Leake, who have been generous with both their time and money in supporting the Junior Academy.

ii. Meeting conflicts

Dean Decker raised an issue which he thought the Committee might want to consider, and that is the problems which arise from other institutions scheduling science events which conflict with the Academy. For instance, Radford faculty know when our meeting is, yet they scheduled a biology symposium at the same time. Perhaps when we know our schedule we should send a letter to various department heads or deans, asking them to try to avoid conflicts.

iii. Speaker for the 1997 meeting

Since the March meeting, Dean Decker has received confirmation of acceptance by speaker Richard Rutan. He will be giving us two talks for a charge of \$3000, for which he normally charges \$10,000. He plans to come on Tuesday and leave on Friday. Dean asked Tom Sitz, as a VPI faculty member, to be sure that the VPI aerospace department knows about Rutan's talks.

c. Vice President, Carolyn Conway

Carolyn Conway reported on the revised procedures to be sure that the people who present papers at the Academy meeting are members and have paid their dues. Starting next year, the Academy will ask for dues when the titles are submitted. Carolyn also suggested that a penalty for presenting a paper without paying dues would be a refusal to publish the abstract. Since some presenters pay their meeting registration and dues with the same check, the easiest way to handle this is for the local arrangements chair to keep track of which people are doing this and then to write a check to the Academy for dues payments.

EXECUTIVE COMMITTEE ACTION: The motion was made, seconded, and passed to 1) request payment of dues at the time that titles of papers are sent in, and 2) to prohibit the publication of abstracts for presenters who have not paid their dues. This will take effect next year.

An additional advantage of the above procedure is that people who pay their dues when they submit their titles are entered into the mailing lists to receive registration materials. The costs of dues and meeting registration fees are very modest compared to most other scientific organizations.

d. Secretary, Joseph Rudmin, No report

e. Treasurer, Greg Cook (absent)

f. Immediate Past President, Elsa Falls

Elsa said that she was happy to represent the Academy at the Virginia Science Museum banquet. She also said that she has enjoyed working with Steven Negus, the Negus lecturer at this year's meeting.

g. Virginia Junior Academy of Science Director, Don Cottingham

1100 participants attended the Junior Academy meeting. He also reported on the meeting of the Junior Academy Committee and on the new loose-leaf format of the Junior Academy Handbook, which should reduce future printing costs. He also announced the Junior Academy Committee summer meeting. He said that regionalization has been shelved for three years.

5. Executive Secretary-Treasurer Blanton Bruner (with Arthur Burke, Jr.) Art Burke reporting:

Blanton Bruner is now 91 years old, and is in good shape mentally, although his knees are giving him problems. I (Art Burke) have hopes of retiring on July first,

1996, at which time I will be able to devote more time to the Academy business. In submitting the 1996 budget, we cut the Executive Secretary-Treasurer's salary from \$8000 to \$4000, anticipating that Blanton would retire after six months, and that Art Burke, his replacement, would draw no salary. Another issue is the problem of space at the Science Museum now and in the future. A director of physical facilities, J. Parry, has been appointed, to coordinate the construction while the Museum has the renovation funds. They will renovate first the east wing and then the west wing of the Broad Street Station. The Museum would like someone from the Academy to discuss space needs with the design architects. There is a two-fold problem. We have materials stored in the cellar, including 3 pallets (4x4x4 feet) of copies of the James River Basin. We are being asked to move this to rented storage, which will cost us three to five hundred dollars per year. Should we pay to store this white elephant or ditch it? We also have two pallets of back-issues of the Virginia Journal of Science. A more serious problem is where will the Academy office move during the renovation of the east wing? The west wing will be vacated at that time. No guarantees have been given, and our position is tenuous at the Science Museum. Don Cottingham said that to secure our rights, it was essential that Ray Carpenter go down there and meet with them personally. Art said that the cooperation between the Academy and the Science Museum was based on some well-meant visions, but that what was needed was a contract. The President of the Academy needs to meet with Walter Witschey, or whomever else is empowered, to work out an agreement and put it in writing. Don Cottingham said that promises were given in writing to the Long Range Planning Committee specifying both office and storage space, and the time commitment of the Associate Director. They have backed off on the Associate Director, but the rest is in writing. Art replied that we should use that letter as a starting point for future negotiations, and that we needed to move expeditiously. J. Parry mentioned that the Model Railroad Association has already given him their requirements, implying that we should respond soon. I'm not sure that we even know what we need, but we should look forward, not backward and act quickly. Otherwise we may find ourselves out in the street. We need to maintain a good rapport with the Museum. Walter Witschey has been very successful in fund raising, and has everything they hoped for for the next seven years. I would strongly suggest that the President of the Academy appoint a small ad hoc committee, including the Executive Secretary-Treasurer, and Lisa Martin, to sound out the Academy concerning space needs for both the seniors and juniors. The sitting President, and the chairman of the Long-range Planning Committee should also be a member. Joe Rudmin asked how much it would cost to store the books. Don Cottingham said that it comes to \$472 per year. Rudmin suggested that this was not an unbearable amount to pay for storage under own control. Don Cottingham said that the Academy had addressed the space problem, and that we decided that our needs were 2200 square feet. This has been repeatedly communicated to Witschey and the Museum in writing. Art said that he and Blanton feel that this is an issue that should be moved on or we may soon find ourselves without an office. Tom Sitz said that he may have a solution to the storage problem, and would know by the end of next week. J. Sergeant Reynolds Community College may provide warehouse space which would be suitable. Joe Rudmin asked Art Burke what his vision was for the eventual solution

to the space problem. Art said that he thought that someday a benefactor would donate a building, along with an endowment for its upkeep.

6. Local Arrangements Committee Reports

a. 1996, Virginia Commonwealth University, Tom Haas (absent)

b. 1997, Virginia Tech, John Hess and Tom Sitz

Tom Sitz reporting. Tom said the current meeting is going well, and he, John Hess, Golde Holtzmann, and Tom Teates, had been meeting monthly, and were on top of things. They have strong support from the President's office. Their plans are outlined in the written report submitted to the last meeting.

7. Old Business

Dean Decker asked Tom to take the meeting scrap book from the display table and to take it to the archives.

8. New Business

Joe Rudmin suggested that, given Blanton Bruner's retirement, perhaps the Council could direct that some money be set aside from the trust fund to provide for an endowed scholarship in his name. Art Burke said that this might be appropriate after he retires. He (Bruner) has funded a scholarship for the support of chemistry graduate students which might be enlarged and named after him. Some of Blanton's in-laws (the Massey family) might view favorably some kind of an endowment honoring him, if approached discretely by the right person. This was followed by a brief discussion on the problems of fund-raising and legislative support. Art Burke expressed the opinion that the best way to generate more fund-raising support is to regionalize the Junior Academy so that more people see local benefit. Joe Rudmin favored highly publicizing VAS Scholarships. Art Burke said that the only way to get things like this done is for some determined volunteer to make it their cause celebre,

9. Concluding Remarks, Tom Sitz thanked everyone for the support he had received during his recent health problems.

10. Adjournment was at 4:10 pm.

**Minutes of the May 22 Meeting
of the Academy Council
of the Virginia Academy of Science**

May 22, 1996, Virginia Commonwealth University, 74th Annual Meeting, 6 pm,
Student Commons Theater, University Student Commons

Present: Thomas O. Sitz (President), R. Dean Decker (President-elect, Science Education Committee), Carolyn M. Conway (Vice President, Biology, Awards Committee), Joseph W. Rudmin (Secretary, Membership Committee), Elsa Q. Falls (First Past President), Gerald R. Taylor (Constitution and Bylaws Committee; Astro. Math, and Physics), Michael L. Bass (Constitution and Bylaws Committee, Environmental Science, Committee on the Environment), Marion Lobstein (Virginia Flora Committee, Botany), Arthur W. Burke, Jr. (Finance and Endowment Committee, Ass't Exec. Sec-Treas), Ann Lund (Natural History and Biodiversity), Ralph Eckerlin (Public Affairs), William Harrison (Biomedical & Engineering), Paul Homsher, D. Rae Carpenter, Jr. (Trust Committee), Vera B. Remsburg (Science Museum of Virginia Trustee), James P. O'Brien (Second Past President, Fund Raising Committee),

Absent: Donald P. Cottingham (Junior Academy of Science Committee, VJAS Director), James H. Martin (Publications Committee, Va. Journal of Science Editor), Ertle Thompson (AAAS/NAAS Rep.) Lisa Martin (Administrative Assistant to the Executive Secretary-Treasurer), Richard B. Brandt (Long Range Planning, Gwathmey and Jeffress Trusts Rep.), Thomas W. Haas (1996 Local Arrangements Committee), Mary Strother (VAST Representative), Greg Cook (Treasurer, Publications Committee, Virginia Scientist Editor), Golde I. Holtzmann (Third Past President, Archives Committee, 75th Anniversary Committee, Nominations and Elections Committee), Eugene B. Barfield (Archaeology, Public Affairs

Committee), Pamela Turpin (Education), Sandra P. Welch (Medical Sciences), Robert A. Berquest (Psychology), Fred H. Lutze (Aeronautical and Aerospace Science), Scott H. Newton (Agriculture, Forestry, and Aquaculture), Eleni Achilleos and Penny Pagona, (Biomedical and General Engineering), George W. Mushrush (Chemistry), Robert A. Willis (Computer Science), Steven Wright (Geography), Kenneth Lawless (Materials Science), Judy H. Niehaus (Research Committee), Francis Macrina, (Microbiology and Molecular Biology), Michael Kosztarab (Natural History and Biodiversity), Paul J. Homsher (Finance and Endowment Committee), John P. Morgan (Statistics), William L. Dewey (Science Advisory Committee), Thomas G. Teates (Science Education Committee), Jack Cranford (Director Visiting Scientists), Blanton Bruner (Executive Secretary Treasurer).

The meeting commenced at 6:10 pm.

1. The participants introduced themselves.

2. The agenda was adopted.

3. The minutes of the previous meeting were approved, subject to submitted corrections.

4. Officers' Reports

a. President, Tom Sitz

Radford has offered to host the meetings in the year 2000, and we have accepted their offer. I have suggested that Judy Niehaus be the chair of the Local Arrangements Committee. The following meeting sites are scheduled: 1997--Virginia Tech, 1998--George Mason, 1999--Old Dominion, 2000--Radford, 2001 and 2002 are unscheduled, and 2003--VCU. We are still seeking a local arrangements chair for ODU.

b. President-Elect, Dean Decker

Dean spent the last two months getting judges for the current VJAS meeting, ending up eight or nine short. He also reported that he has engaged Richard Rutan as the speaker for the 1997 VAS and VJAS meeting. Mr. Rutan flew the Voyager aircraft around the world without refueling.

d. Vice President Carolyn Conway.

This year I have tried to keep track of the membership. Many presenters at the VAS meeting are not members, as required by the rules. Presenters were to have paid their dues by the fifteenth of May.

COUNCIL ACTION: Art Burke noted that the Executive Committee had passed a resolution to establish a policy of requesting dues at the time that titles, are sent in, with the proviso that if dues are not paid, the abstract will not be published. He then moved that the Council endorse this motion. His motion was seconded and passed unanimously.

Carolyn reported that VCU is establishing a \$2000 scholarship to be awarded to a member of the Virginia Junior Academy of Science who will be attending VCU.

d. Secretary, Joseph Rudmin: No Report

e. Treasurer Greg Cook: Absent

f. Executive Secretary-Treasurer Blanton Bruner (with Arthur Burke, Jr.)

Art Burke reporting: Blanton is having problems with his knees, although he is mentally sound. Blanton will retire in July, at which time Art Burke expects to take over his duties, serving without pay, and assisted by Lisa Martin.

g. 1994-5 President Elsa Falls:

Elsa reported that she and her husband enjoyed representing the Academy at the banquet of the Virginia Science Museum, and has also had the pleasure of

communicating via email with Dr. Steve Negus in preparing for the current meeting.

h. 1993-4 President Jim O'Brien:

Motion: At the March meeting of the Council, Jim O'Brien requested a leadership retreat in the Fall of 1996. The motion was made to give Jim the go-ahead to arrange this retreat. The motion was seconded and approved. Following this was a discussion about disposing copies of the book "The James River Basin". Jim reported that the Book Press Limited of Williamsburg has agreed to retail the book at \$50/copy, with half the price being returned to the Academy. The Academy on its part agrees not to permit the book to be sold to the general public at less than \$50.

i. 1992-3 President Golde Holtzman: Absent

5. Local Arrangements Committee Reports

a. 1996, VCU, Chair Tom Haas: Absent, but undoubtedly busy.

b. 1997, Virginia Tech: John Hess and Tom Sitz: getting judges

6. Directors and Representatives Reports

a. Junior Academy of Science, Don Cottingham:

b. Visiting Scientist's Program, Jack Cranford, absent.

c. AAAS Representative, Ertle Thompson:

d. Science Museum of Virginia, Trustee Vera Remsburg:

The Museum has been given 18 acres and a house on the James River at Lock Lane. The fundraising campaign has reached 27 M\$ of its 30 M\$ goal. Renovation of the grounds will be completed next year. In the meantime, the VAS needs to tread lightly and skillfully to maintain our interests.

e. Jeffress and Gwathmey Memorial Trust Allocation Committee, Richard Brandt.

7. Standing Committee Reports

a. Archives Committee, Golde Holtzman, absent.

b. Awards Committee, Robert Johnson, absent, Carolyn Conway reporting: No nominations for special awards were received this year.

c. Constitution and Bylaws, Co-Chairs Michael Bass and Gerald R. Taylor: No report.

d. Environment Committee, Chair Michael Bass: no report.

e. Finance and Endowment Committee, Co-chairs Arthur Burke and Paul Homsher: Art Burke reporting:

The budget is currently in arrears, but receipts may well exceed expenditures during the coming year. The Academy is financially sound.

f. Fund-raising, Chair James O'Brien: see above.

g. Junior Academy of Science, Chair Don Cottingham. absent.

h. Long Range Planning, Richard Brandt, absent.

i. Membership, Scott Newton and John P. Morgan absent.

j. Nominations and Elections Committee, Golde Holtzman, absent.

k. Publications Co-Chairs:

i. Virginia Journal of Science, Editor James H. Martin

ii. Virginia Scientists, Editor Greg Cook.

l. Research, Judy H. Niehaus, absent--report read by J Rudmin

The Research Committee is pleased to fund 6 proposals for Small Projects Grants. The recipients are Dr. Rafael O. de Sa of the Univ. of Richmond, Dr. Eugene G. Maurakis and Dr. William S. Woolcott of the Science Museum of Virginia, Ms. Laura P. McDonald and Dr. Jack A. Cranford of Virginia Tech, Dr. Orion Rogers of Radford Univ., Dr. Heide Scrable and Ms. Wendy Siemon of Charlottesville, and Ms. Nikita Warty and Dr. Charles L. Rutherford of Virginia Tech. The winner of the J. Shelton Horsley Research Award for 1996 is Dr. Khidir W. Hilu from Virginia Tech for the paper "Phylogenetic Construction with matK: Walking Along the Gene", which will be presented in the Botany Section.

m. Science Advisory, Chair William L. Dewey, absent.

n. Science Education, Co-Chairs Thomas G. Teates and Maurice P. Lynch absent.

o. Trust, Rae Carpenter, Jr.: Finances are in good shape. We are pursuing the idea of transferring some of our funds to a smaller fund than Investment Company of America.

p. Virginia Flora, Chair J. Rex Baird absent.

8. Special Committee Reports

a. Futures, Chair Rae Carpenter, Jr.

b. Public Affairs, Chair Ralph Eckerlin

c. 75th Anniversary, Chair Golde Holtzman absent

9. Section Representatives Reports

a. Aeronautical and Aerospace Sciences, no report.

b. Agriculture, Forestry, and Aquaculture, no report.

c. Archaeology, no report.

d. Astronomy, Math, and Physics. Gerald Taylor: AM&P had a full program.

e. Natural History and Biodiversity. Ann Lund: Biodiversity had 19 papers, one poster session and one invited speaker. The invited speaker is Teta Kain, an ornithologist, speaking on "Plover Paradise: Barrier Island Nesting Surveys." Most abstracts have been submitted.

f. Biology, Carolyn Conway:

g. Biomedical Engineering, Bill Harrison: Our section is getting increasing requests for computer-controlled LCD projectors.

h. Botany, Marion Lobstein: Botany is having a hard time getting papers due to increased internal and external competition for people's time.

i. Chemistry, no report.

j. Computer Science, no report.

k. Education, no report.

l. Environmental Science, Mike Bass:

m. Geography, Gerald Taylor reporting: Geography will beat the bushes to improve participation.

n. Geology, no report.

o. Materials Science, no report.

p. Medical Sciences, no report.

q. Microbiology and Molecular Biology, Tom Sitz reporting: We had five papers, and expect more next year.

s. Psychology, Jim O'Brien: Papers are coming in.

t. Statistics, John Morgan: We have received six titles for the meeting.

10. Old Business

Marion Lobstein brought up the following resolution:

VAS RESOLUTION REGARDING EQUITY OF TEACHING CREDIT AND TEACHING LOAD FOR SCIENCE FACULTY TEACHING LABORATORY COURSES

At the 1995 VAS annual meeting a resolution supporting the importance of laboratories in science education received unanimous support of Academy members. However, at most public and many private colleges and universities in Virginia, teaching credits for laboratory teaching is often only given one third to one half that of lecture experience. The credit hours of science faculty teaching loads are often much higher than that of colleagues in other disciplines. Such inequity of teaching credit and teaching loads of science faculty at these institutions does not reflect the importance of the laboratory experience.

RESOLUTION

In Association with other scientific groups and organizations, the Virginia Academy of Science strongly supports the concept of equity of teaching credit and teaching loads for faculty teaching laboratory courses. The laboratory experience is an integral and critical component of science courses. Teaching loads and credit afforded to faculty teaching laboratory courses should reflect equity relative to that of faculty in other disciplines.

COUNCIL ACTION: The Council endorsed the following resolution and approved its submission to the Academy Conference.

11. New Business

12. Concluding Remarks, President Tom Sitz: None

13. Adjournment was at 7:41 pm.

Virginia Academy of Science Academy Conference**74th Annual Meeting, May 23, 1996****Room 1164, General Purpose Academic Building, VCU Campus**

President Tom Sitz opened the Conference at 4:45 pm. He recognized Tom Haas, chair of the Local Arrangements Committee, and thanked Tom, the LAC, and the VCU staff for a job well-done. He reported that in response to a request by James Poland, VCU will establish a scholarship of \$2000 to be awarded to a VJAS graduating senior. John Hess (Past director of the VJAS) and Tom Sitz are the local arrangement Chairs for next year's meeting, which will be held at Virginia Tech, May 20-23, 1997, along with the help and guidance of Golde Holtzman.

Finance and Endowment Committee Report: Arthur W. Burke, Co-chair of the Finance and Endowment Committee, issued a report stating that the finances of the Virginia Academy of Science are in good order, and that the Academy is solvent.

Nominating Committee Report: Golde Holtzman, chair, introduced the new officers of the Academy. They are Dean Decker--President, Harold Marshall--President-Elect, Carolyn Conway--Vice President, Judy Niehaus--Secretary, and Darcy Mays--Treasurer.

Awards Committee Report: Robert Johnson, chair, announced the student awards winners.

New Business:

Marion Lobstein reported to the conference that the Council had endorsed the following resolution, and approved its submission to the Academy Conference.

**VAS RESOLUTION REGARDING EQUITY OF TEACHING CREDIT
AND TEACHING LOAD FOR SCIENCE FACULTY
TEACHING LABORATORY COURSES**

At the 1995 VAS annual meeting a resolution supporting the importance of laboratories in science education received unanimous support of Academy members. However, at most public and many private colleges and universities in Virginia, teaching credits for laboratory teaching is often only given one third to one half that of lecture experience. The credit hours of science faculty teaching loads are often much higher than that of colleagues in other disciplines. Such inequity of teaching credit and teaching loads of science faculty at these institutions does not reflect the importance of the laboratory experience.

RESOLUTION

In Association with other scientific groups and organizations, the Virginia Academy of Science strongly supports the concept of equity of teaching credit and teaching loads for faculty teaching laboratory courses. The laboratory experience is an integral and critical component of science courses. Teaching loads and credit afforded to faculty teaching laboratory courses should reflect equity relative to that of faculty in other disciplines.

After extensive discussion, the resolution was unanimously approved by the Academy membership present at the Conference.

The Conference adjourned at 5:30 pm.

**Minutes of the May 24 1996 Meeting
of the Executive Committee
of the Academy Council
of the Virginia Academy of Science**

University Student Commons, Alumni Association Board Room, Virginia
Commonwealth University, 8:30 am, May 24, 1996

Members Present: R. Dean Decker (President), Harold Marshall (President-Elect), Carolyn M. Conway (Vice President), Judy Niehaus (Secretary), Darcy Mays (Treasurer), Thomas O. Sitz (Immediate Past President).

Others Present: Arthur W. Burke, Jr. (Assistant Executive Secretary-Treasurer), Gerald Taylor (Co-Chair, Constitution and Bylaws Committee), Joseph W. Rudmin (Outgoing Secretary), Larry Snedden, (photographer), D. Rae Carpenter (Trust Committee), Michael Bass, (Co-Chair, Constitution and Bylaws Committee) Vera Remsburg, Golde Holtzman, Richard Brandt, William Hanson, Ertle Thompson.

Members Absent: Donald R. Cottingham (Director, Junior Academy of Science).

The meeting commenced at 8:30 am.

1.Introductions: Participants introduced themselves.

2.Adoption of the agenda: This practice is herewith discontinued.

3.The minutes of the May 22 meeting were not available.

4.Officers' Reports

a.President, Dean Decker:

i.Changes in the ECL Miller Science Club Award: Wednesday evening, the Junior Academy Committee made some changes in awards. The ECL Miller award, a \$50 prize was given to the science club which had the best record of activity. Science clubs are no longer active within the Academy. There were no applications for the ECL Miller Award this year. Besides this, there was an award for science club sponsors, and the VAS has been giving a teacher award of \$200 from the budget. The VJAS Committee has recommended combining these and increasing the award to a \$500 teacher award. The South Carolina Junior Academy gives a teacher of the year award which is an all-expense paid trip to the AAAS AJAS Meeting. Recipients have told me that this was one of the most exhilarating experiences they have had. The VJAS Committee accordingly decided to establish the ECL Miller Teacher of the Year Award, which would consist of expenses to the AAAS annual meeting. The existing funds for the previous three awards have been budgeted items totaling \$450. If the AAAS meeting were in Baltimore or DC, this would cover the registration, room and travel. It wouldn't cover a meeting in Seattle. But the committee knows where the meeting is each year to budget a sufficient amount in advance. We propose to budget this annually into the Junior Academy Budget. No VAS approval is needed.

Art Burke said that the award should be a fixed amount, say \$500, with the teacher keeping or paying the difference, provided they attend the meeting. Joe Rudmin replied that a teacher would not go if he or she had to pay hundreds of dollars to go to the meeting. Rae Carpenter: There should be a fixed fund, from which the awards are taken, taking it out of the annual budget. But the amount would not be highly flexible. Dean Decker said that the Junior Academy should go ahead with the award, and seek to get the award endowed later. Joe Rudmin suggested that the Academy simply put an upper limit on the award. If the meeting were in Hawaii, there would be no award that year. Tom Sitz asked if there might be alternative meetings to an expensive meeting? Art Burke asked where the next meeting would be. Ertle Thompson replied that the next one was Seattle, then Philadelphia, then Anaheim. Art Burke said that there should also be a standing committee of the VJAS whose work was to monitor the award and make sure that it was used and not abused. Rae Carpenter commented that if the award got up to \$1200 the Academy should ask if honoring the teacher was as beneficial as say giving a student a scholarship to college. Dean Decker said that since the proposal came from the Junior Academy Committee, it constituted a motion which needed no second. "We need to vote it up, down, or amend it."

VJAS Committee Motion: The VAS Teacher Award, Sponsor Award, and ECL Miller Club Award should be combined to create the ECL Miller Teacher of the Year Award, it being an expense-paid trip to the AAAS-AJAS Annual Meeting.

Jerry Taylor noted that the Constitution and Bylaws Article XI, section C, require the Director of the Junior Academy to prepare a budget and submit it with the VJAS Committee recommendations to the Academy Finance and Endowment Committee by September 1. He moved that the recommendation of the VJAS committee should go through the established budgeting process, and that action by the Council be tabled until November when this action will have been carried out.

EXECUTIVE COMMITTEE ACTION: The motion to table the previous motion until November was made, seconded, and approved.

ii. Appointments to be recommended to Council:

Chair of the Trust Committee--Rae Carpenter for 3 more years.

Gwathmy & Jeffress Trust Representative: Elsa Falls

Virginia Science Museum Trustee: (3 names have been submitted to the Science Museum)

Editors of the Virginia Journal of Science and the Virginia Scientist: James Martin and William Cunningham (Tidewater Community College), Visiting Scientist Program: Jack Cranford

Executive Secretary-Treasurer: Blanton Bruner

Assistant Executive Secretary-Treasurer: Art Burke

iii. There was some discussion about changing the schedule of duties to be more workable. This will be handled by Dean Decker, Carolyn Conway, and Lisa Martin.

iv. VJAS Scholarships Awarded by Schools: Dean Decker recommended appointing an ad hoc committee to create some guidelines for handling these, since the number is growing. The committee will consist of Jerry Taylor, Tom Sitz, and Carolyn Conway.

v. New name for the VJAS Distinguished Service Award: The Ad Hoc Committee to make recommendations for this will consist of Rae Carpenter, Vera Remsburg, and Ertle Thompson.

b. President-Elect: No report.

c. Vice President, Carolyn Conway, No report.

d. Secretary, Judy Niehaus, No report.

e. Treasurer, Darcy Mays, No report.

f. Immediate Past President, Tom Sitz: We are seeking to have UVA host the annual meeting in the year 2001.

g. Virginia Junior Academy of Science Director, (absent)

5. Executive Secretary Treasurer, Art Burke reporting: No report

6. Local Arrangements Committee Reports

a. 1996, Virginia Commonwealth University, Carolyn Conway: No report.

b. 1997, Virginia Tech, Tom Sitz: "Everything is on track."

7. Old Business None

8. New Business

a. The VAS and the Science Museum of Virginia: Rae Carpenter said that the relationship between VAS and the SMV needs to be handled carefully. He reported that the problem of storing Journals and copies of "The James River Basin" may have been solved by transferring them to another institution in the Richmond area. If not, then we will be dealing with the SMV when storage becomes a problem. This will be difficult due to the pressures caused by renovation. Dean Decker said that he would be talking with Walter Witschey about the problems this summer. Rae said that the museum officers have been supportive and generous. Vera Remsburg said that Walter attended the academy banquet in a convivial spirit. She said that he noted the graying of the Academy. Vera expressed agreement with Walter, that more young people need to be recruited. Gerald Taylor said that he had invited Walter Witschey and Betty Blatt to the banquet. He recommended that Rae Carpenter be present during any discussions with Witschey due to his continuity and the mutual trust between Rae and Walter. The relationship between the VAS and SMV is of mutual benefit. Richard Brandt felt that the VAS should seek to recover its lost half-time position at the SMV which was authorized by the legislature. Both Richard and Gerry cautioned against having informal discussions with Walter without Rae being present.

9. Concluding Remarks: None

10. Adjournment was at 9:37 am.

**Minutes of the May 24, 1996 Meeting
of the Academy Council
of The Virginia Academy of Science**

May 24, 1996, Virginia Commonwealth University, 74th Annual Meeting Student Commons Alumni Association Board Room, 9:30 am

Present: R. Dean Decker (President), Harold Marshall (President-elect), Carolyn M. Conway (Vice President), Judy H. Niehaus (Secretary), Arthur W. Burke, Jr. (Finance and Endowment Committee, Ass't Exec. Sec-Treas), Thomas O. Sitz (Immediate Past President, 1997 Local Arrangements Committee), Elsa Q. Falls (Second Past President), James P. O'Brien (Third Past President, Fund Raising Committee), Gerald R. Taylor (Constitution and Bylaws Committee; Astro. Math, and Physics), Golde I. Holtzmann (Archives Committee, 75th Anniversary Committee, Nominations and Elections Committee), Richard B. Brandt (Long Range Planning, Gwathmey and Jeffress Trusts Rep.), William Harrison (Biomedical & Engineering), Paul Hansher, D. Rae Carpenter, Jr. (Trust Committee), Vera B. Remsburg (Science Museum of Virginia Trustee), Ertle Thompson (AAAS/NAAS Rep.) Joseph W. Rudmin (Outgoing Secretary, Membership Committee).

The meeting commenced at 9:30 am.

1. The participants introduced themselves.
2. Adoption of the agenda is herewith and hereafter discontinued.
3. The minutes of the May 22, 1996 were not available for approval.
4. Officers' Reports
 - a. President, Dean Decker

COUNCIL ACTION: The appointment of Rae Carpenter to another three-year term as head of the Trusts Committee was moved, seconded, and approved.

COUNCIL ACTION: The appointment of Elsa Falls as representative to the Gwathmey and Jeffress Trusts Allocation Committee Representative was moved, seconded, and approved.

COUNCIL ACTION: The appointment of William Cunningham as Editor of the Virginia Scientist was moved, seconded, and approved.

The continuation of Jack Cranford as Director of the Visiting Scientists Program was reported. There was some discussion of the program.

Jim Martin has agreed to serve as editor of the Journal for another year and has been reappointed.

COUNCIL ACTION: Dean Decker reported that the recommendation of the Executive Committee is to continue the present situation of Blanton Bruner as Executive Secretary-Treasurer, and Art Burke as Assistant Executive Secretary-Treasurer for the time being. At the end of June, Blanton Bruner's salary will cease, and Art Burke will continue to serve without pay. The reappointment of these two people was moved, seconded, and approved.

A tentative Schedule of Events was distributed and discussed. Carolyn Conway said that the scheduling of nominations needs to be reworked.

Following this was a discussion on how to increase the student participation in the VAS Banquet at future meetings. Joe Rudmin suggested reducing the cost of the Banquet to less than that of eating in a restaurant.

Next was a discussion about improving attendance at the May Council meetings. Ertle Thompson said that moving the Wednesday meeting to the evening had adversely affected attendance, because many members were working on awards committees which had to deliberate at that time. Elsa Falls said that having the meeting in the afternoon excluded Council members who were judges and session chairs. Dean Decker said that compounding the problem was the decrease in the number of active VAS members. There are fewer people trying to cover more jobs, and this creates conflicts. Council members should avoid over-committing themselves. Jerry Taylor said that the Academy needs to bring in more young people. This is discouraged, because the state doesn't recognize Academy service as a creditable activity. Ertle Thompson said that one avenue for bringing in these younger members is through inviting them to be Junior Academy session chairs and judges. He said that the Council should meet Wednesday afternoon, leaving the younger faculty to handle chairing and judging. The more senior members could then participate in awards selection in the evening. Jim O'Brien said that more Committee Chairs should be appointed among the Section Counselors and Chairs, to bring them into the active circle. These chairs and co-chairs should be educated concerning their responsibilities, and should be encouraged to get at least one thing done with their committee. Joe Rudmin suggested that committee chairs be phoned prior to the meeting, asking them to attend. Richard Brandt said that he did this when he was president. Jerry Taylor suggested putting the committee chairs' names in the agenda. Dean Decker asked this to be postponed to Old Business in the November meeting.

Dean Decker appointed an ad hoc committee to establish guidelines to implement scholarships awarded by colleges to VJAS members. This committee consists of Jerry Taylor, Tom Sitz, and Carolyn Conway.

The Distinguished Service Award for the Junior Academy has no name and could be named to honor a past member of the Academy. Dean Decker appointed an ad hoc committee to make recommendations to the Council concerning naming

this award. The ad hoc committee consists of Vera Remsburg, Rae Carpenter, and Ertle Thompson.

- b. President-Elect, Harold Marshall, no report.
- c. Vice President Carolyn Conway.

Carolyn noted the absence of many awardees at the Academy Conference. She suggested that this ceremony be dropped, and that the awards simply be mailed to the recipients. Bill Harrison suggested that the senior sponsors should instruct the recipients to attend. Tom Sitz said that the Negus lecture is the highlight of the meeting, and attending it would be a good experience. Bill Harrison noted that even the numerous VCU students did not attend. Jim O'Brien said that the awards winners in the Education section were simply announced at the end of the presentations. He felt this was a good practice, and that recognitions at the Academy Conference be restricted to those present. Carolyn says that the problem is the timing and gathering the information. She suggested trying procedures one more time as is, with more emphasis on instructing the sponsors to encourage participation. Joe Rudmin said that he thought that many Academy members think that the Conference and the Negus lecture are only for the inner clique. He felt that a line should be added to the program saying "Will ALL members of the Academy please try to attend these events." Carolyn Conway asked for email suggestions.

- d. Secretary, Judy Niehaus: No Report
- e. Treasurer: Absent

f. Executive Secretary-Treasurer Blanton Bruner (with Arthur Burke, Jr.): absent At the Academy Conference, he issued a written report stating that the finances of the VAS are in good order and that the Academy is solvent.

- g. Second Past President Elsa Falls:

Elsa raised the question of publicizing the Academy Conference Resolution on Teaching Credit and Teaching Equity for Science Faculty Teaching Laboratory Courses. Tom Sitz said that he would take care of this. Elsa noted that the Richmond Times Dispatch front page carried an item about a pseudo-science conference at UVA, but did not mention the VAS-VJAS meeting. Carolyn replied that this was a slip up by the public relations office at VCU.

Elsa expressed dismay at the poor attendance by Council members of the Council meeting. Carolyn replied that in many sections which had only Thursday meetings scheduled, the councilors had left. Those with Friday meetings were at those meetings. Some sections actually ran concurrent sections to avoid a two-day schedule. Joe Rudmin noted that Committee Chairs weren't present either. Committee meetings were scheduled from 8:15 to 9:15. He asked if any of those committees met.

5. Local Arrangements Committee Reports

- a. 1996, VCU, Carolyn Conway:

For the Senior Academy, there were 250 pre-registered, and about 100 on-site registrants. For the Juniors, about 500 registrants stayed in the dorms, about 400 others came, and 60 paid parents and about 200 free parents. Dean Decker said

that the unregistered people created a shortage of programs. Tom Sitz suggested printing an extra box of programs to mitigate this problem. Joe Rudmin suggested printing up extra sheets consisting of a schedule of events and a map might help.

COUNCIL ACTION: The Council recognises, the local arrangements committee, Carolyn Conway, Tom Haas, and VCU for a job well-done. Tom Sitz said he would send a thank-you letter to President Trani.

b. 1997, Virginia Tech: Tom Sitz said that everything is in good shape. Dean Decker reminded the Council that Richard Rutan is the invited speaker.

6. Directors and Representatives Reports

a. Virginia Junior Academy of Science,

Dean Decker reported, that the VJAS was well-represented at the national meeting in Baltimore by Bryan Green of Arlington High School. Ertle Thompson said that several of the papers would do credit to a university professor and that they deserved more public recognition.

b. Visiting Scientist's Program, Jack Cranford, absent.

c. AAAS Representative, Ertle Thompson: It was another great meeting. I cannot give enough accolades to Brian Green, who was the VJAS award winner.

d. Science Museum of Virginia, Trustee Vera Remsburg: absent

e. Jeffress and Gwathmey Memorial Trust Allocation Committee, Richard Brandt.

We just had the May meeting, and there will be a report in the Journal. The Jeffress award has six renewals of about \$10,000 each, and there were 32 new grants applied for of which 20 were funded, more than usual, because the stock market performed so well this year. The amount of money in the Jeffress exceeds \$300,000. For the Gwathmey, there were 39 requests, and about \$200,000 was allocated to 23 proposals. The academy would be well-advised to seek funding from the Gwathmey fund to support a history of the Academy. This should be in the neighborhood of \$10,000. Contact Sam Gillespie for more details. Dean Decker, at Jerry Taylor's suggestion, said that he would appoint Jerry Taylor, Golde Holtzman, and Vera Remsburg to be an ad hoc committee to look into getting a Gwathmey grant, before November, to complete the history of the Academy.

7. Standing Committee Reports

a. Archives Committee, no report.

b. Awards Committee, Carolyn Conway: The deadline for nominating fellows is Oct 1. As many as two may be awarded. It is the responsibility of the membership to nominate people. Nomination letters signed by 3 VAS members are required.

c. Constitution and Bylaws, Co-Chairs Michael Bass and Gerald R. Taylor: The Constitution and Bylaws are in good shape. In November we will consider the modifying the selection process for Chair of the Research Committee. Recommendations are welcome. Dean Decker asked this to be brought up in November Old Business.

d Environment Committee, Chair Michael Bass: Mike reported that Richard Collins is the director of the new Center for Environmental Negotiation at UVA. Joe Rudmin added that the JMU Geology department is launching a BS in Environmental Science.

e. Finance and Endowment Committee, Co-chairs Arthur Burke and Paul Homsher: absent.

f. Fund-raising, Chair James O'Brien:

Our pledges range from ten dollars to five thousand. We have sixtyseven donors, and total pledges are \$29580, of which over \$12,000 has been received. We are seeking support from other organizations, starting with the American Association of Naval Engineers. We are also trying to develop a fund for a VJAS Associate Director.

James River Basin: The Book Press in Williamsburg is willing to sell the book in the store and in the catalogue for \$50, of which \$25 would be returned to the VAS, provided the Academy agree not to permit sale of the book to the public elsewhere for less than this. Joe Rudmin said that he believed that the consensus of the earlier meeting was that we should try this for a year and see how the sales go. The Council gave Jim the go-ahead to make arrangements.

g. Junior Academy of Science, Chair Don Cottingham. absent.

h. Long Range Planning, Richard Brandt, no report

i. Membership, Scott Newton and John P. Morgan absent.

There was some discussion about instituting emeritus membership, and the new brochure for membership was distributed.

j. Nominations and Elections Committee, Jim O'Brien: We will perform our duties earlier this year.

k. Publications Co-Chairs:

i. Virginia Journal of Science, Editor James H. Martin absent

ii. Virginia Scientists, Editor absent

l. Research,

The Research Committee is pleased to fund 6 proposals for Small Project Grants. The recipients are Dr. Rafael O. de Sa of Richmond, Dr. Eugene Maurakis and Dr. William S. Woolcott of the Science Museum of Virginia, Ms. Laura P. McDonald and Dr. Jack Cranford of Virginia Tech, Dr. Orion Rogers of Radford, Dr. Heidi Scrable and Ms. Wendy Siemon of Charlottesville, and Ms. Nikita Wary and Dr. Charles L. Rutherford, of Virginia Tech. The winner of the

J. Shelton Horsley Research Award for 1996 is Dr. Khidir W. Hilur from Virginia Tech for the paper "Phylogenetic Construction with matK: Walking along the Gene", which will be presented in the Botany Section.

m. Science Advisory, Chair William L. Dewey, absent.

n. Science Education, Co-Chairs Thomas G. Teates and Maurice P. Lynch absent. Tom Sitz reported that he has asked the committee to address the problem of pressure by fundamentalists groups to teach creationism in biology classes.

o. Trust Committee, Rae Carpenter, Jr.

The Trust Committee's report was distributed. Highlights of this report were that the trusts total \$435,368, up 6.7% since December. A breakdown by fund was given.

p. Virginia Flora, Chair J. Rex Baird absent.

8. Special Committee Reports

a. Futures. The Futures Committee has expired.

b. Public Affairs, Chair Ralph Eckerlin absent

c. 75th Anniversary, Chair Golde Holtzman, Stickers for cars and windows displaying the 75th Anniversary Logo were distributed. We give our thanks to Nancy Patterson and George Lobstein for originating them. We will produce the history which we have been working on for four years, and distribute it at the meeting. There was discussion about the Junior Academy T-shirts.

9. Section Representatives Reports

a. Aeronautical and Aerospace Sciences, no report.

b. Agriculture, Forestry, and Aquaculture, no report.

c. Archaeology, no report.

d. Astronomy, Math, and Physics. Gerald Taylor: AM&P had a full schedule and good attendance.

e. Biology, Carolyn Conway: We had a full day, and the papers went well.

f. Biomedical Engineering, Bill Harrison: We had a good meeting.

g. Botany, Marion Lobstein: There is a problem with overlap of Botany.

h. Chemistry, Tom Sitz: Chemistry had a full slate and a successful meeting.

i. Computer Science, absent.

j. Education, absent.

k. Environmental Science, absent:

l. Geography, absent

m. Geology, absent.

n. Materials Science, absent.

o. Medical Sciences, Richard Brandt: Medical Sciences had 35 papers.

p. Microbiology and Molecular Biology, Judy Niehaus: We met!

q. Natural History and Biodiversity, absent.

r. Psychology, Jim O'Brien: A full meeting, and everything was fine.

t. Statistics, John Morgan: absent

10. Old Business, none.

11. New Business, none.

12. Concluding Remarks, none.

13. Adjournment was at 11:30 am.

NOTES

NOTES

Membership in the Academy is organized into sections representing various scientific disciplines as follows:

- | | |
|--|---------------------------------------|
| 1. Agriculture, Forestry & Aquaculture | 10. Psychology |
| 2. Astronomy, Mathematics & Physics | 11. Education |
| 3. Microbiology & Molecular Biology | 12. Statistics |
| 4. Biology | 13. Aeronautical & Aerospace Sciences |
| 5. Chemistry | 14. Botany |
| 6. Materials Sciences | 15. Environmental Science |
| 7. Biomedical & General Engineering | 16. Archaeology |
| 8. Geology | 17. Computer Science |
| 9. Medical Sciences | 18. Geography |
| | 19. Natural History & Biodiversity |

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EDITOR/BUSINESS MANAGER:

James H. Martin

Dept. of Biology - PRC

J. Sargeant Reynolds Community College

P.O. Box 85622

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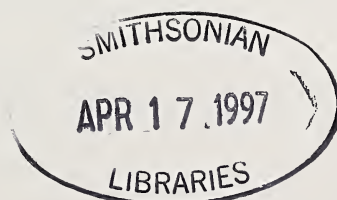
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Effects of the June 1995 Freshet on The Main Virginia Tributaries to the Chesapeake Bay¹

Herbert M. Austin and Christopher F. Bonzek, School of Marine Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062

ABSTRACT

Environmental conditions in the Virginian waters of the Chesapeake Bay area during the summer of 1995 have been characterized as a severe drought. This drought was punctuated on 27 June with a headwater (James and Rappahannock River) rain storm that produced a "freshet". Although it did not rain in the Tidewater area of Virginia, surface salinities were depressed by the run-off, and main-stem bottom oxygen levels dropped to zero in the James and Rappahannock rivers. The effects of the reduced oxygen were apparent on the James River oyster stock, particularly the reduction in spatfall, and to a lesser degree on the Rappahannock River young-of-the-year striped bass index. Long-term effects of the June flood and/or the drought must be monitored.

INTRODUCTION

The Virginia Institute of Marine Science (VIMS) has collected surface and bottom physical environmental data from the Virginia river tributaries to the Chesapeake Bay as part of the juvenile finfish trawl survey for 40 years (Bonzek et al 1995). These were collected coincident with the biological data (species enumeration) since the survey's inception in 1955. These data have included surface and bottom salinity (ppt), temperature (C), and oxygen (ppm) from the river mouth (mile 0) to as far up each river as the survey penetrates. For most years the cruises were up the main stem of each river. The tributaries are the Rappahannock, York, and James Rivers.

This 40 year period has allowed the development of a climatological profile for the rivers, both physical and biological (Bonzek et al 1995). Over the years this has allowed VIMS scientists to note both episodic perturbations and longer term trends (Wojcik 1978, Norcross 1983). Departures from the climatological norm were particularly severe during 1995, and while the general pattern was one of a drought (VDMTF 1995), heavy rains in the mountains of Virginia during June produced anomalous conditions that had profound biological impacts downstream in the estuarine-marine environment. The purpose of this report is to bring together the VIMS data sets, as well as other reports, describing the down-stream impacts of this June 1995 storm.

METHODS

VIMS instituted the "trawl survey" in April 1955 as a series of mid-channel stations in the York River, VA. By 1964 the Rappahannock and James Rivers had become part

of the monthly survey. Today, a station consists of a five minute tow with a 30' semi-balloon otter trawl parallel to the isobaths. Tow speed is approximately 2.5 knots (3.8 K/h). Surface and bottom hydrographic data (temperature, salinity and oxygen) are measured following each tow. More detailed sampling protocols are reported in Bonzek et al (1995) and Land et al (1995).

RESULTS

Researchers in the field began, in early July 1995, to notice anomalous conditions in the Rappahannock and James rivers that were possibly related to torrential rains that on 27 June dropped up to 31.6 in (803 mm) on the Rapidan River (James River drainage) at Ruckersville, Madison Co. Rainfall was estimated to have exceeded 4 in/h (23 mm) (Michaels 1995). In Madison Co. alone 35,000 acres of crops were destroyed or damaged; state-wide there were eight deaths, 2,000 homes destroyed or damaged, and total damage estimated to exceed \$112 million. The York, which drains the Piedmont plain of Virginia, did not show the effects of this rain.

On average, in 1995 the Chesapeake Bay drainage streamflow was well below normal (USGS 1995), and in fact during April 1995 a record low flow value was recorded (<60,000 cu ft). Air temperatures each month were above normal (per comm, State Climatologist's Office) averaging +1-2 F (1 C) in Richmond and +2-5 F (3-4 C) in Norfolk. This situation is reflected in the river surface and bottom water temperatures, depicted in the May-August 1995 plots (Fig 1-24). The heavy mountain rains on 27 June produced a low salinity surface flow, a freshet, that not only brought an extreme sediment load, but also served to intensify June stratification and resulted in an up-river (mile 25, kilometer 46) dissolved oxygen sag in both the James and Rappahannock. By July the oxygen had become depleted in both rivers from around river mile 25 (kilometer 46) to the mouth. The situation was particularly acute in the James River (Fig 14c).

Streamflow data from the United States Geological Survey (USGS) show spring 1995 running about one third of 1994's. The Palmer Drought Index (Palmer 1964) for the late summer 1995 in Tidewater, Virginia was -4.04 (VDMTF 1995), the lowest on record. Bay-wide the drought is apparent in the USGS streamflow data. The June freshet, while increasing the Rappahannock and James flow, did very little, however, to increase the overall Bay-wide discharge for the summer months as the rain fell locally on the head waters of these rivers in the western part of Virginia.

Figures 1 through 24 present graphs of salinity, dissolved oxygen (DO), and water temperature, by river and approximate river mile, for May through August 1995. Each graph presents the historical mean (represented by the lines with solid points), values for the present year (represented by the lines with open points), and the historical minimum and maximum values (represented by the lower and upper shaded areas, respectively).

In mid-July there were reports from the Virginia Department of Emergency Services, and the Virginia Marine Resources Commission of resource--particularly oysters--problems in the James. Our own survey personnel (trawl survey and juvenile striped bass survey) reported persistent discoloration of the water, and dead or dying catfish, carp and gar in the up-stream reaches of the Rappahannock.

DISCUSSION

Eastern oysters, *Crassostrea virginica*, are effected by salinities below 6-7 ppt, which reduce feeding and growth rates. If lower salinities occur when temperatures are below 10.0 C they have little impact as oysters are dormant. But when low salinities occur during spring through fall when oysters are growing, storing glycogen, or preparing to spawn, these activities cease (Austin et al., 1989, Zaborski and Haven, 1980). Oyster spatfall was almost completely absent from the Virginia tributaries of the James and Rappahannock through August, and was attributed to the heavy June runoff. The freshwater runoff "...apparently wiped out spatfall during the peak period between mid-July and mid-August" (Morales-Alamo, 1995). The Virginia Marine Resources Commission, monitoring the oyster beds, noted that the June "freshet" produced an influx of freshwater downstream, and resulted in mortalities of up to 90% on some public oyster rocks (Deepwater Shoal) in the James River, and close to 100% on some private grounds. Further, it interrupted the peak of the spawning season (Andrew-Spear, 1995).

The Virginia young-of-the-year striped bass (*Morone saxatilis*) survey, which consists of five rounds of samples between river miles 12-15 (kilometer 22) up to 76-78 (kilometer 144) during the first week of July through September, also documented the effects of the June flood (Austin et al, 1996). The survey found warmer than normal shore temperatures (32.0 C, normal range is mid-20's), and lower than normal shore salinities (5 ppt, normal range is 15-20 ppt) as far down river as river miles 12 to 22 (kilometer 22) in both the James and Rappahannock. Researchers who conducted the survey also reported that

"The river (Rappahannock) was quite turbid...extending down river to mile R37 (kilometer 68). While no dead or dying striped bass were caught in our samples, dead and dying fish were encountered along the river and many reports from other sources were noted. We did note that juvenile striped bass in our samples appeared to be emaciated and in generally poor condition."

The primary long term impact of the June flood was the record depression of the mid-river bottom oxygen levels to near zero or zero levels. May and June surface and bottom salinities generally ran 2.5 to 5 ppt above the long term average and oxygen levels were generally average. In July salinities were generally 2.5 ppt below average, a one month drop of 5 to 8 ppt, river-wide. Most dramatic were hypoxic and anoxic conditions. While anoxic conditions are fairly typical in parts of the mid-Rappahannock, they extended from about river mile 25 (kilometer 46) in both the Rappahannock and James to mile 10 (kilometer 18.5) in the Rappahannock, and to the mouth of the James River. By August, salinity conditions were back to near the long term norm in all rivers; but oxygen remained below normal, hypoxic down to the mouth of the Rappahannock River, and anoxic from river miles 10 to 20 (kilometer 18.5-37) in the Rappahannock.

Not since Hurricane Agnes in 1972 has a June flood produced such a summer-long impact on the physical environment (Anderson 1973) and subsequent biological impacts on the biota (e.g. oyster: Haven et al. 1976; Setsler, 1989). It is interesting to speculate too on the possible impacts of Agnes on striped bass recruitment as the 1972 year class was the lowest on record. It may be some time before the eventual record

shows whether or not the June 1995 flood approaches any of the long term Agnes impacts. Primary among the impacts may be the reduction in oyster recruitment of the already severely depressed James River oyster stocks. Fortunately, unlike Agnes the impacts should not be Bay-wide.

CONCLUSIONS

The spring-summer 1995 marine-estuarine lower Chesapeake Bay environment was characterized as in extreme drought with unusually high salinities. In the middle of this (27 June) there was an extreme rainfall event in the headwaters of the Rappahannock River, and particularly the James River which produced an episode of heavy streamflow, a freshet. This produced a freshwater lens that overlay the more saline deeper water, causing increased stratification, and which carried tons of sediment into the lower rivers. The combination of these events produced hypoxic and anoxic conditions that lasted for nearly a month. The effects of the combined drought with a freshet on the biota are unknown, but will become apparent in the future.

ACKNOWLEDGEMENTS

Austin is a Principle Investigator on the "trawl survey" contract, "Estimation of Relative Juvenile Abundance of Recreationally Important Finfish in the Virginia Portion of Chesapeake Bay", and Bonzek is the Data Management Head of the VIMS Fisheries Data Management Unit, Department of Fisheries at VIMS. The work is currently funded by the USFWS/VMRC Wallop-Breaux project No. F-104-R-6.

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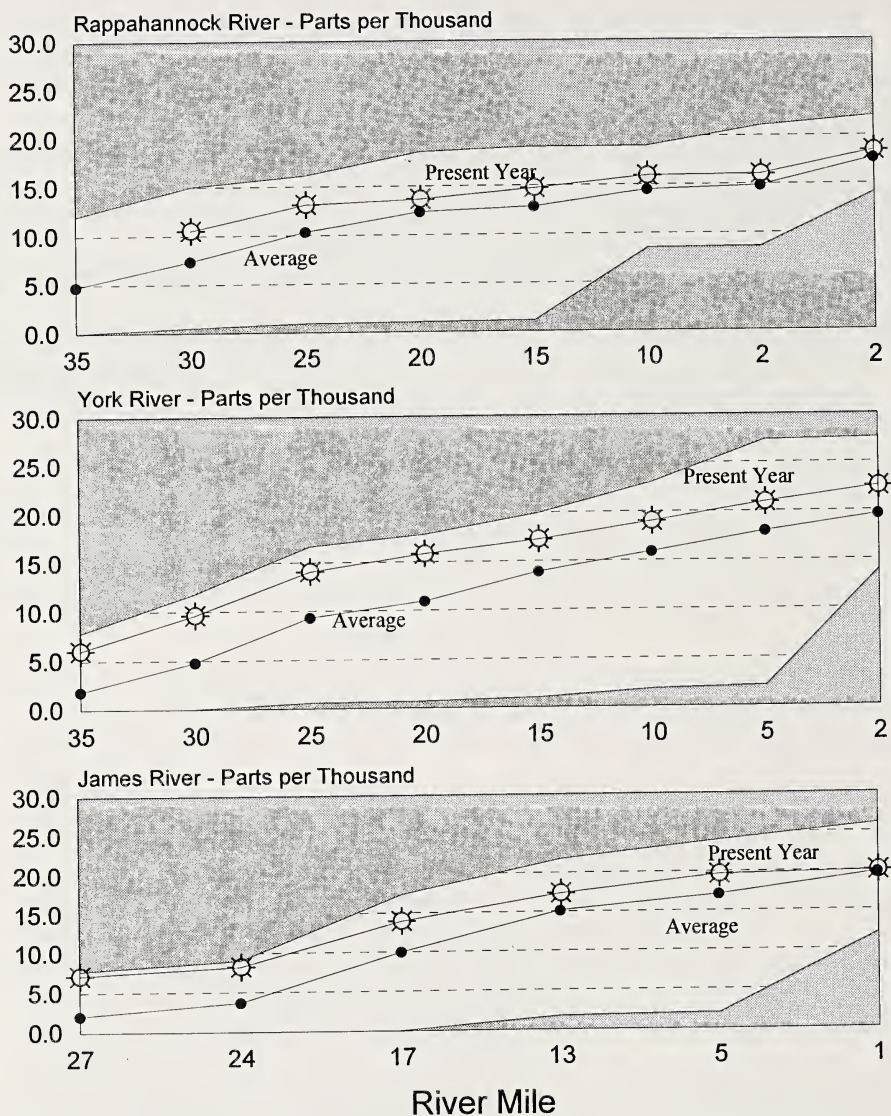


FIGURE 1a-c. Bottom salinity, May 1995, James, York and Rappahannock rivers, VA.

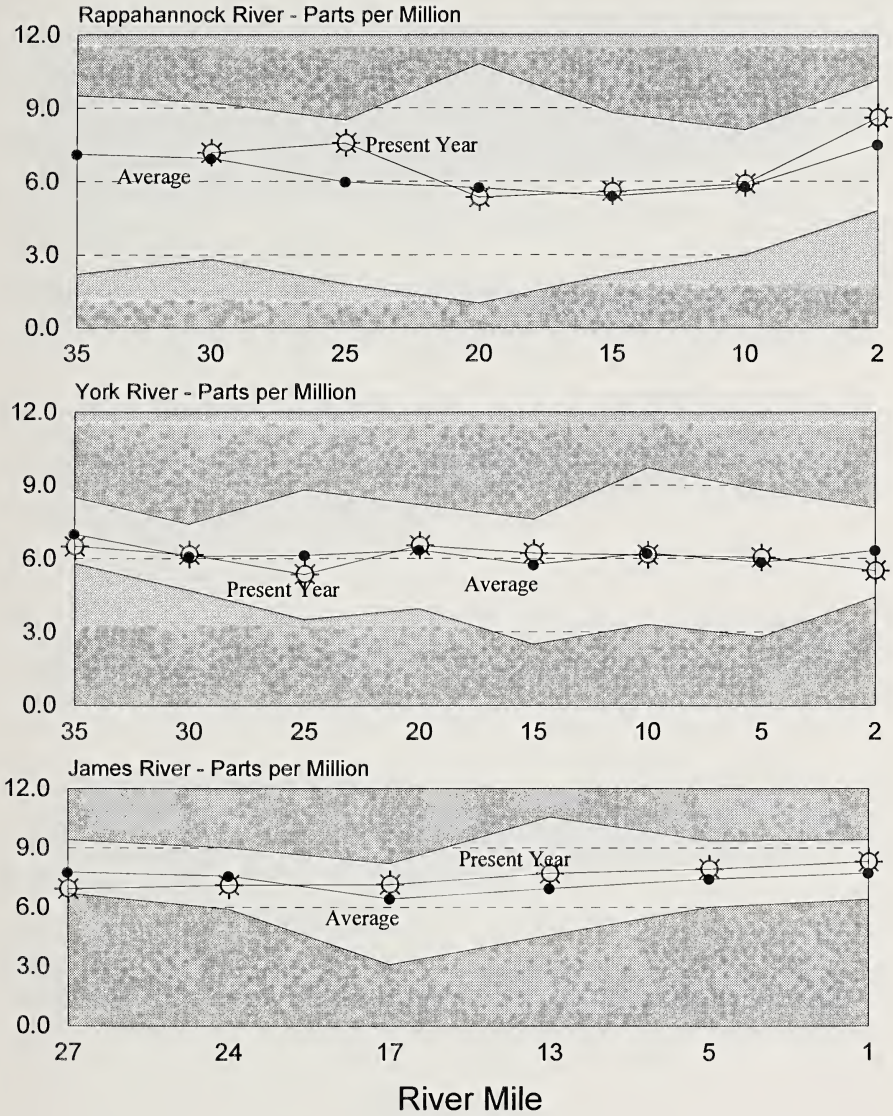


FIGURE 2a-c. Bottom dissolved oxygen, May 1995, James, York and Rappahannock rivers, VA.

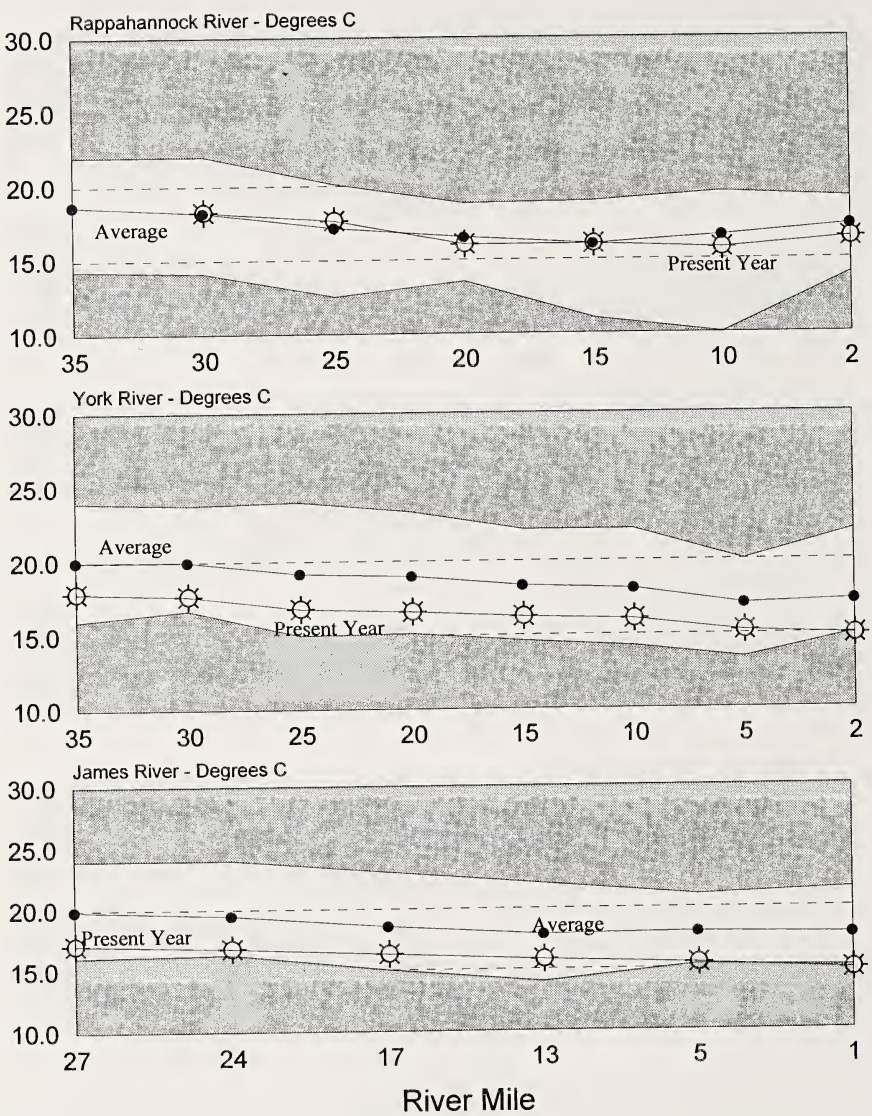


FIGURE 3a-c. Bottom water temperature, May 1995, James, York and Rappahannock rivers, VA.

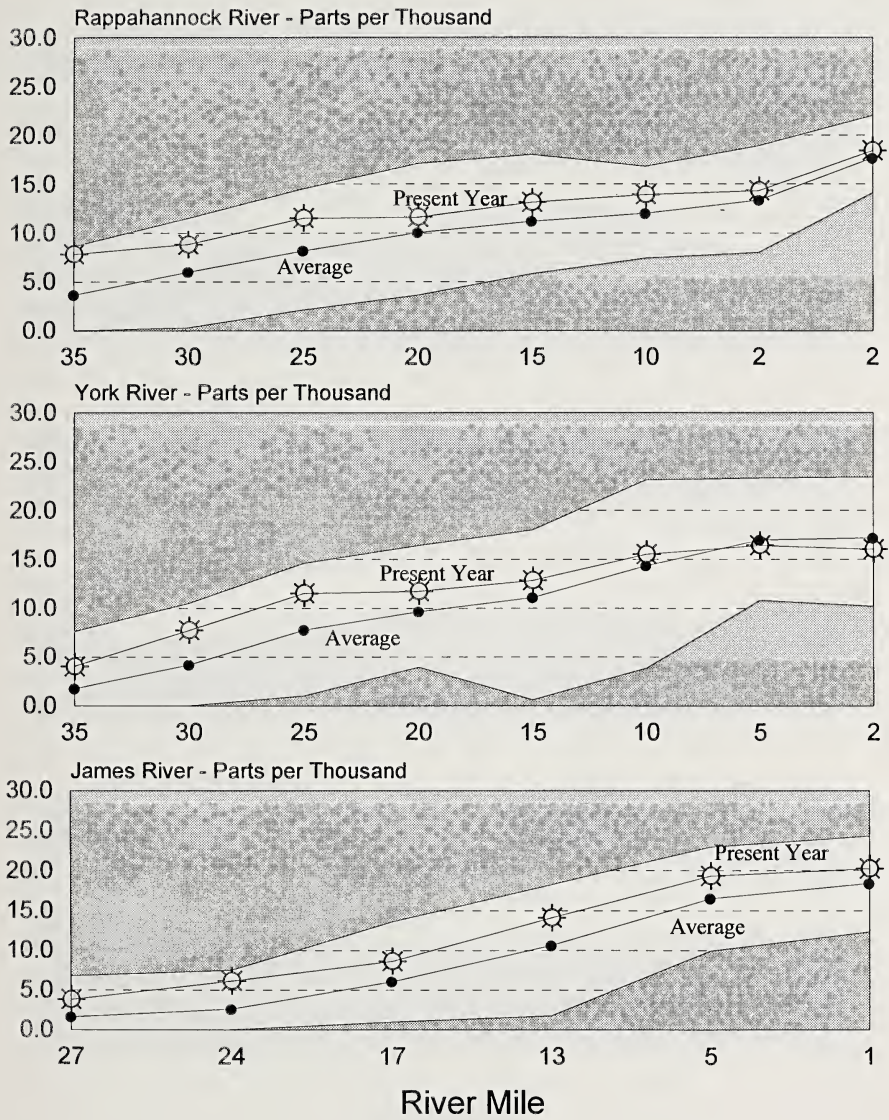


FIGURE 4a-c. Surface salinity, May 1995, James, York, and Rappahannock rivers, VA.

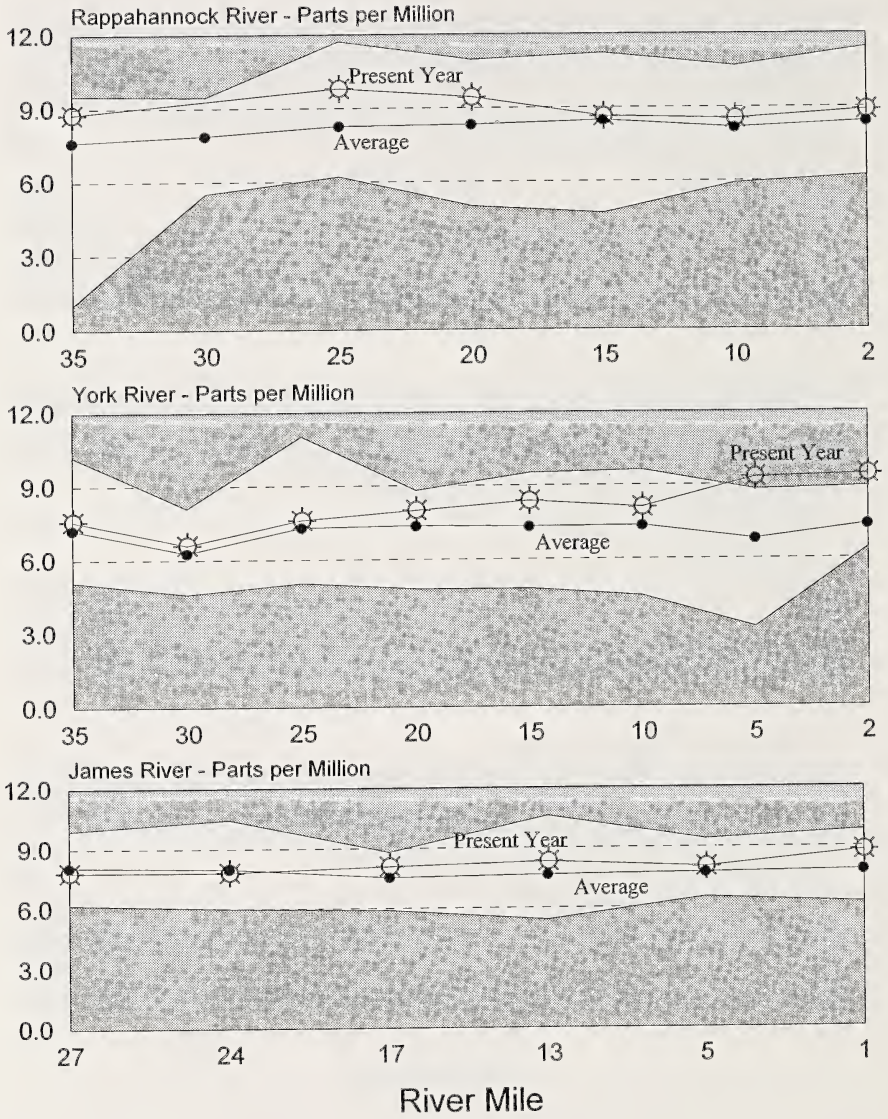


FIGURE 5a-c. Surface dissolved oxygen, May 1995, James, York and Rappahannock rivers, VA.

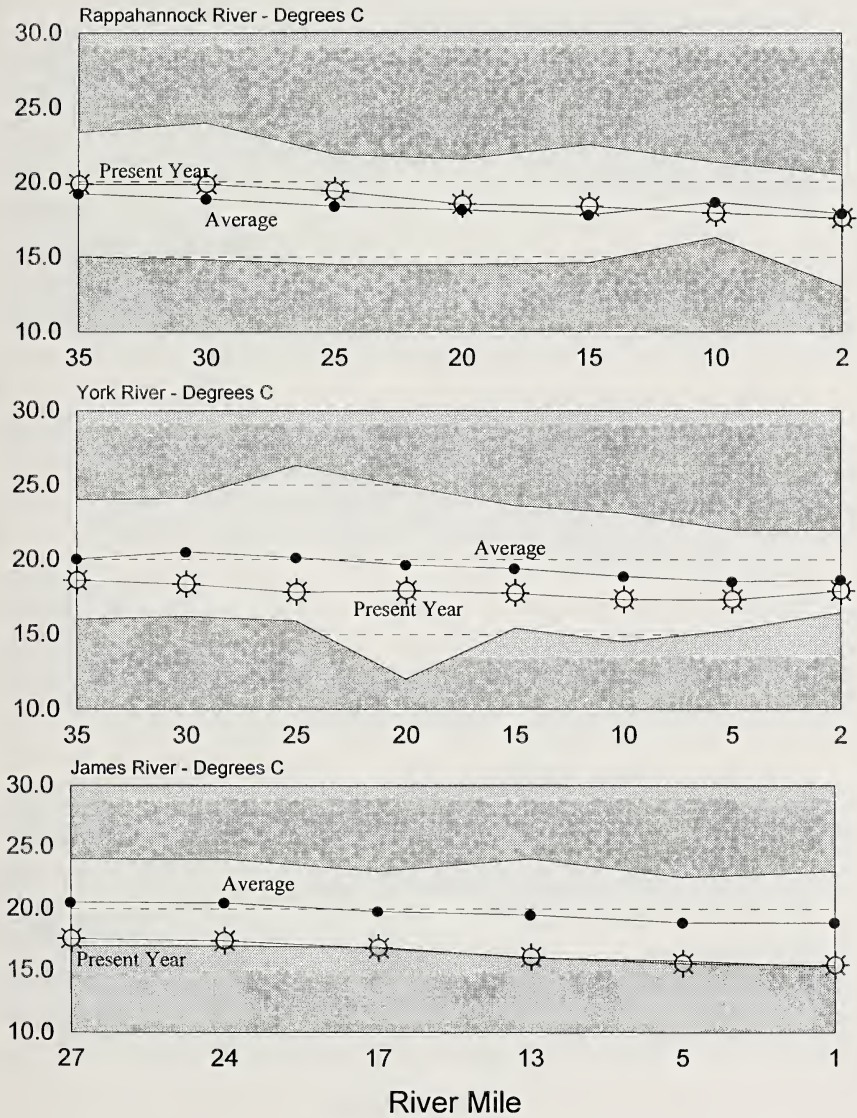


FIGURE 6a-c. Surface water temperature, May 1995, James, York and Rappahannock rivers, VA.

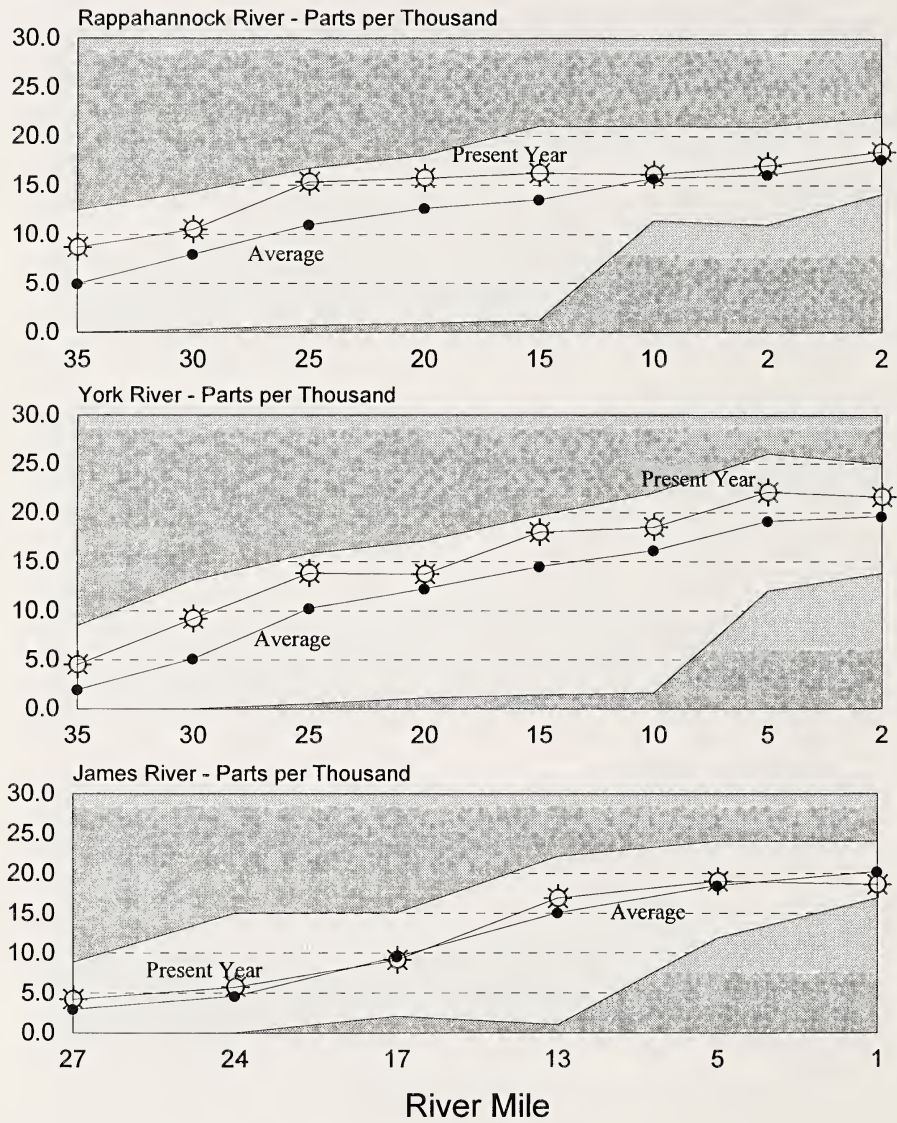


FIGURE 7a-c. Bottom salinity, June 1995.

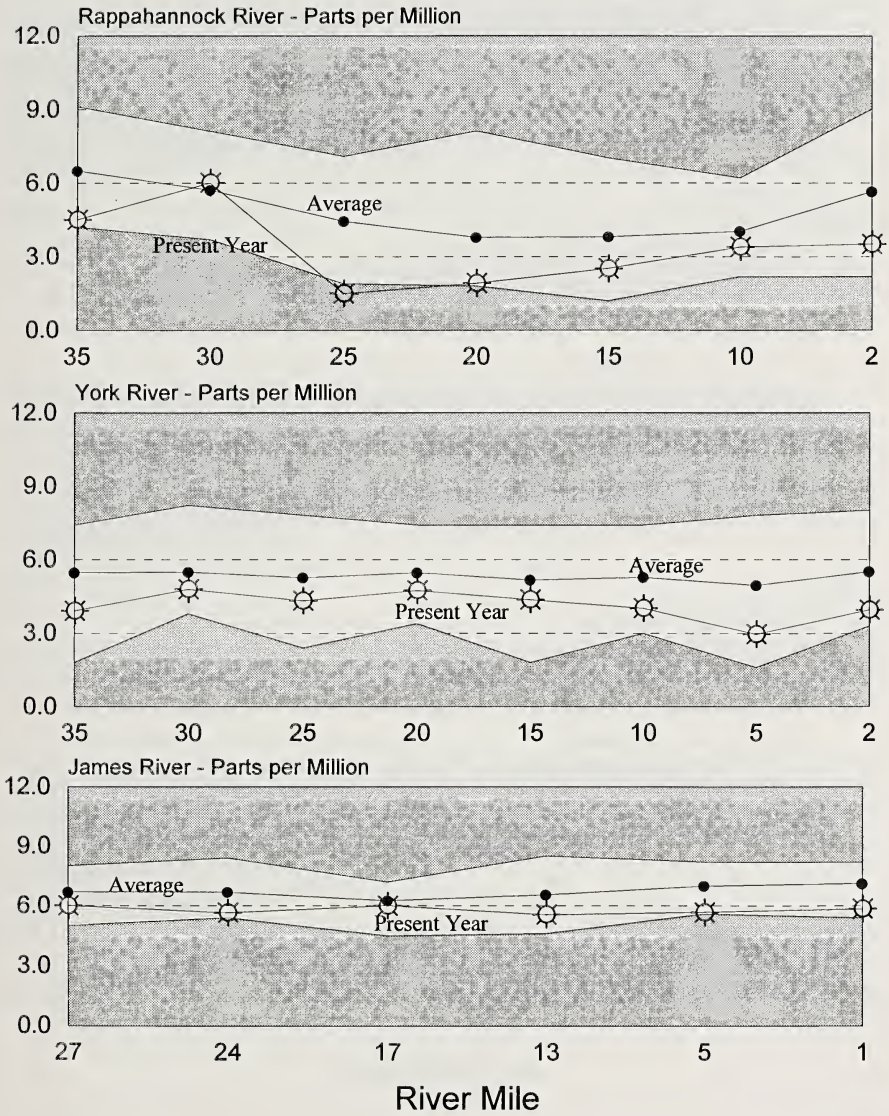


FIGURE 8a-c. Bottom dissolved oxygen, June 1995.

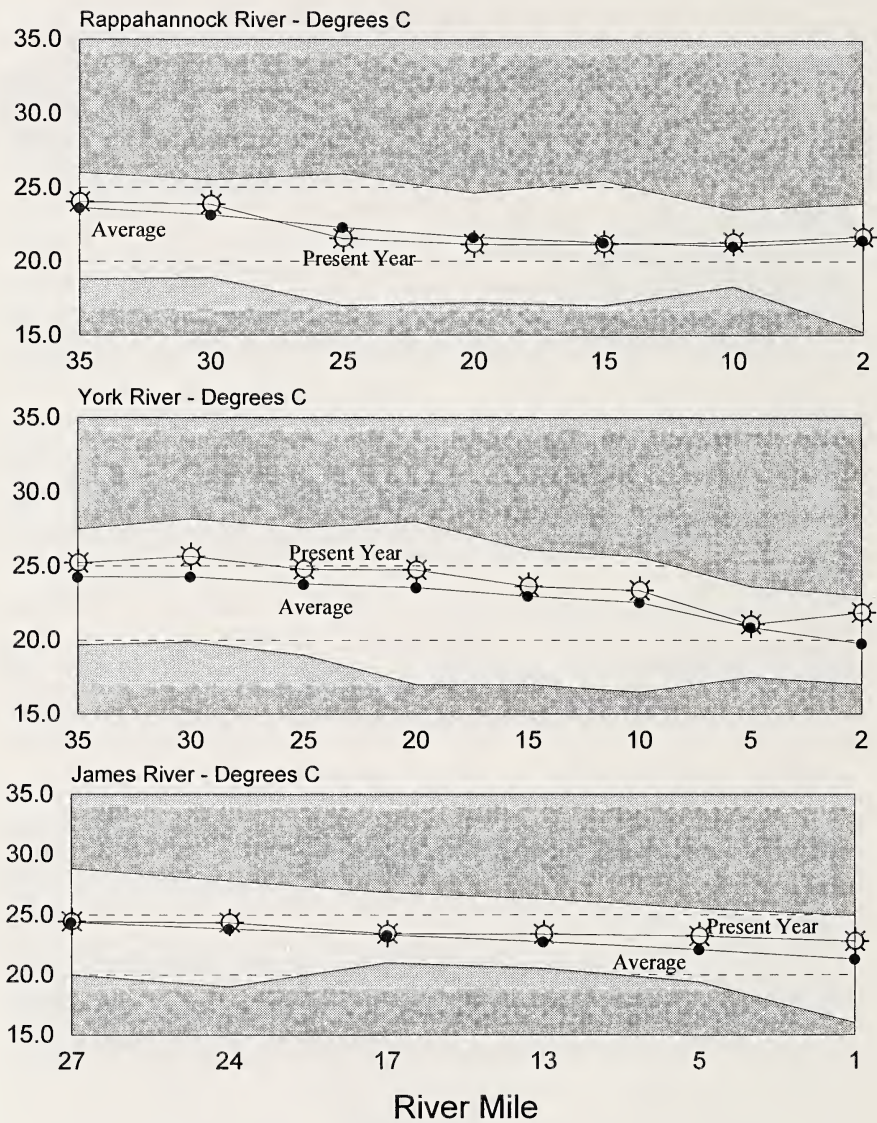


FIGURE 9a-c. Bottom water temperature, June 1995.

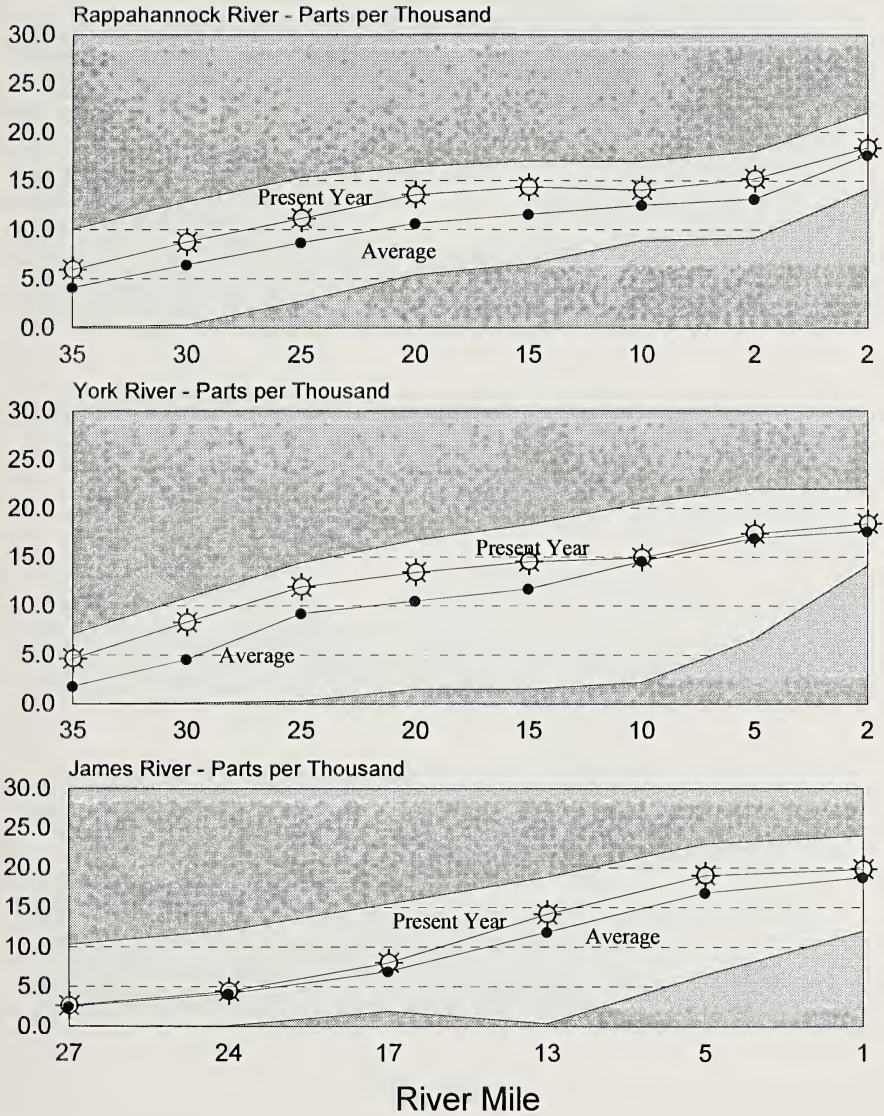


FIGURE 10a-c. Surface salinity, June 1995.

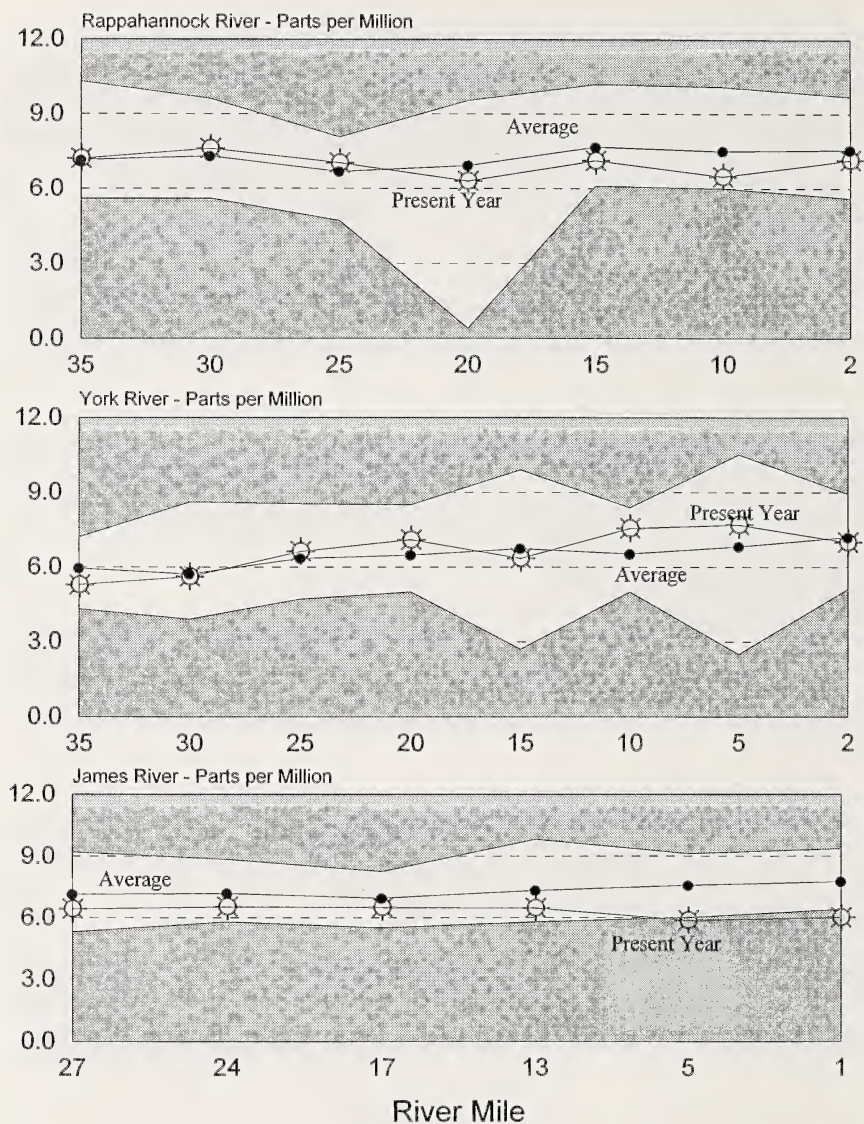


FIGURE 11a-c. Surface dissolved oxygen, June 1995.

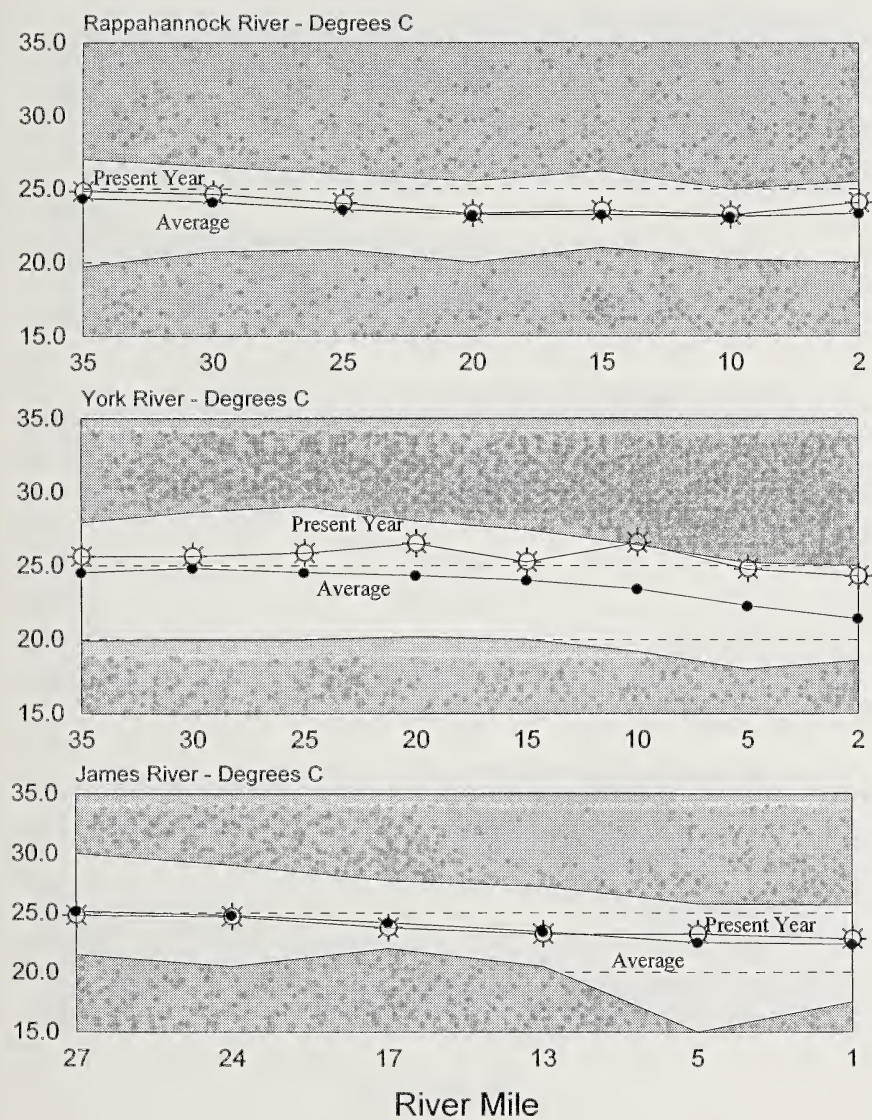


FIGURE 12a-c. Surface water temperature, June 1995.

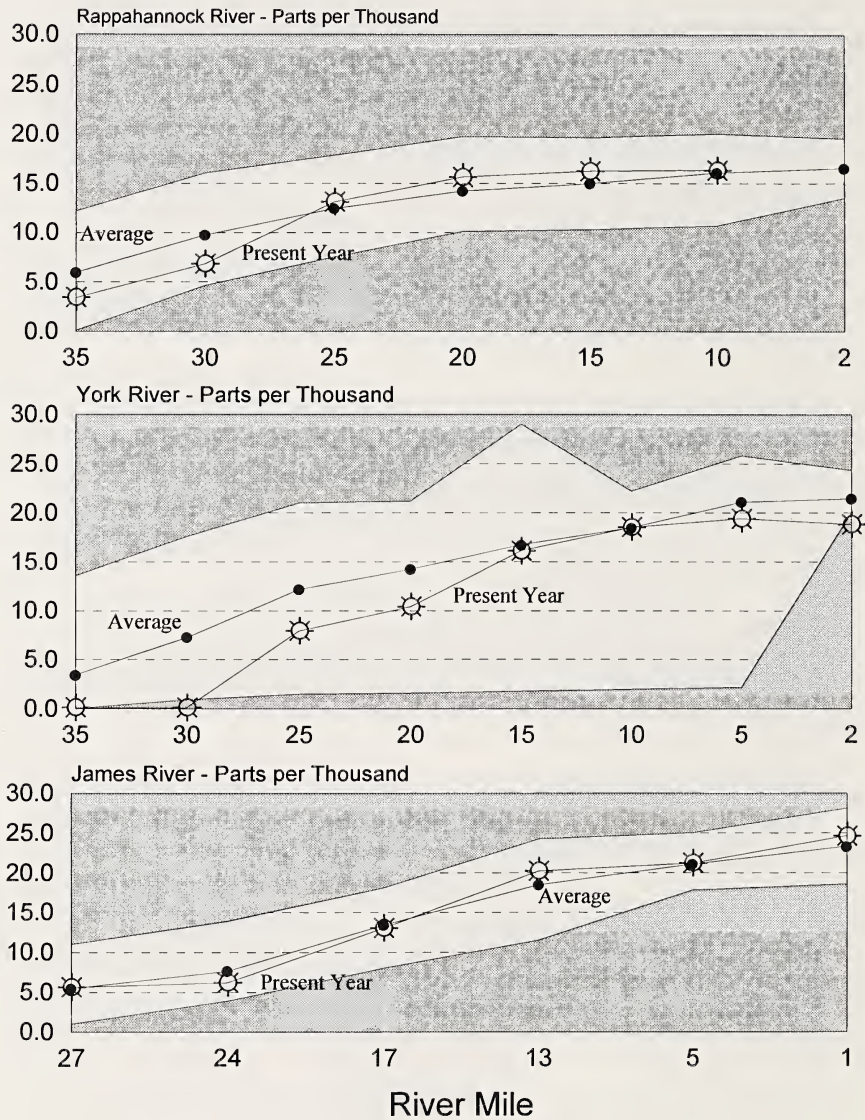


FIGURE 13a-c. Bottom salinity, July 1995.

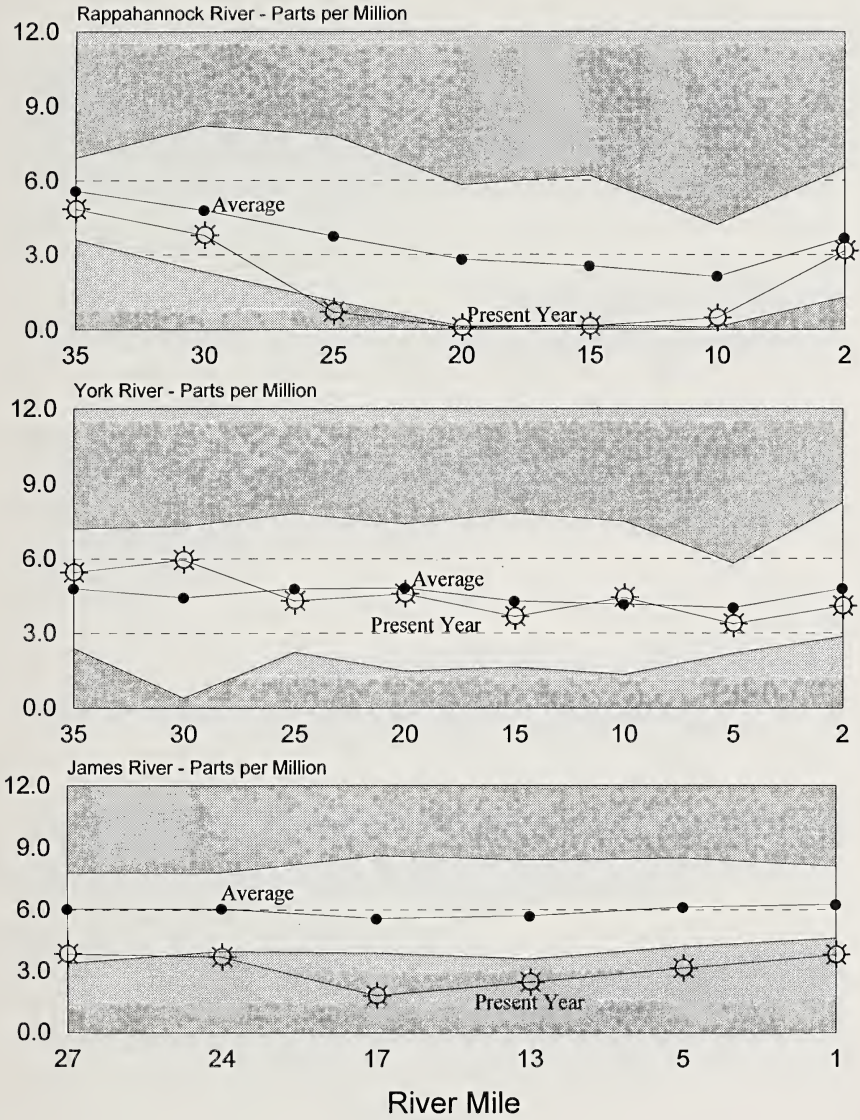


FIGURE 14a-c. Bottom dissolved oxygen, July 1995.

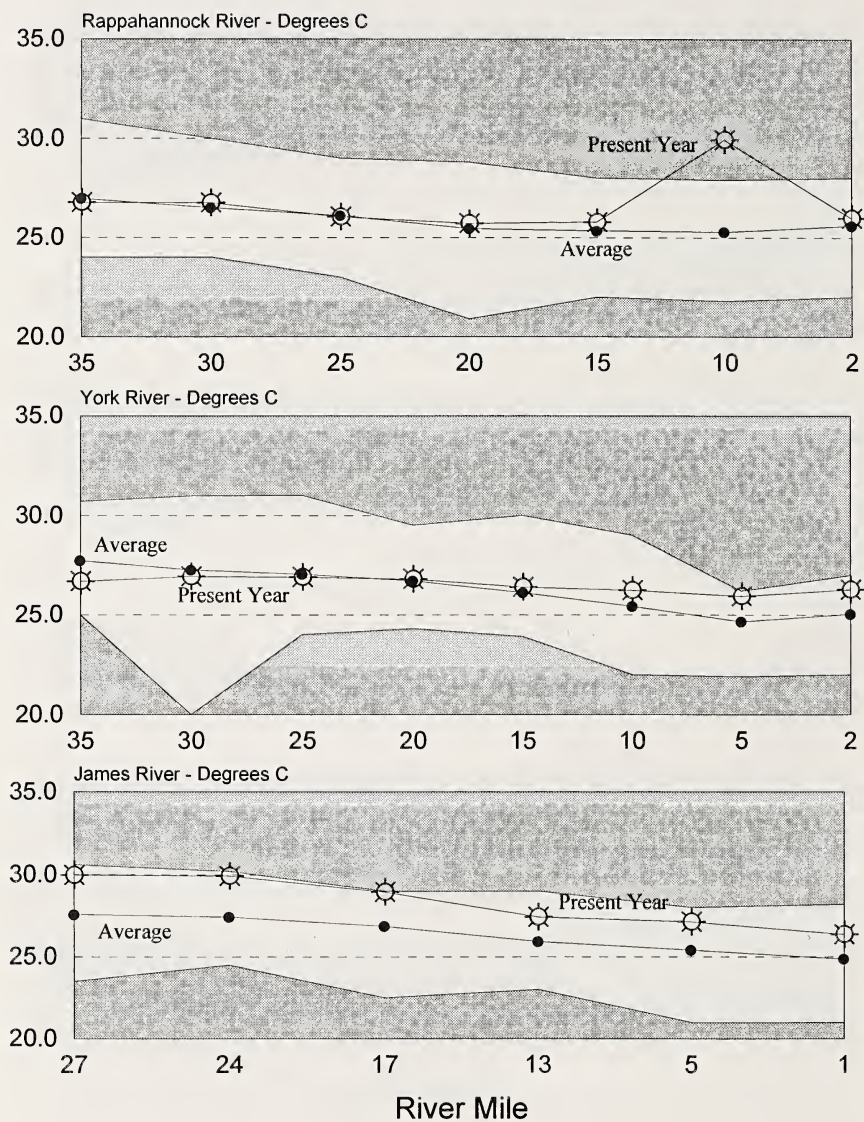


FIGURE 15a-c. Bottom water temperature, July 1995.

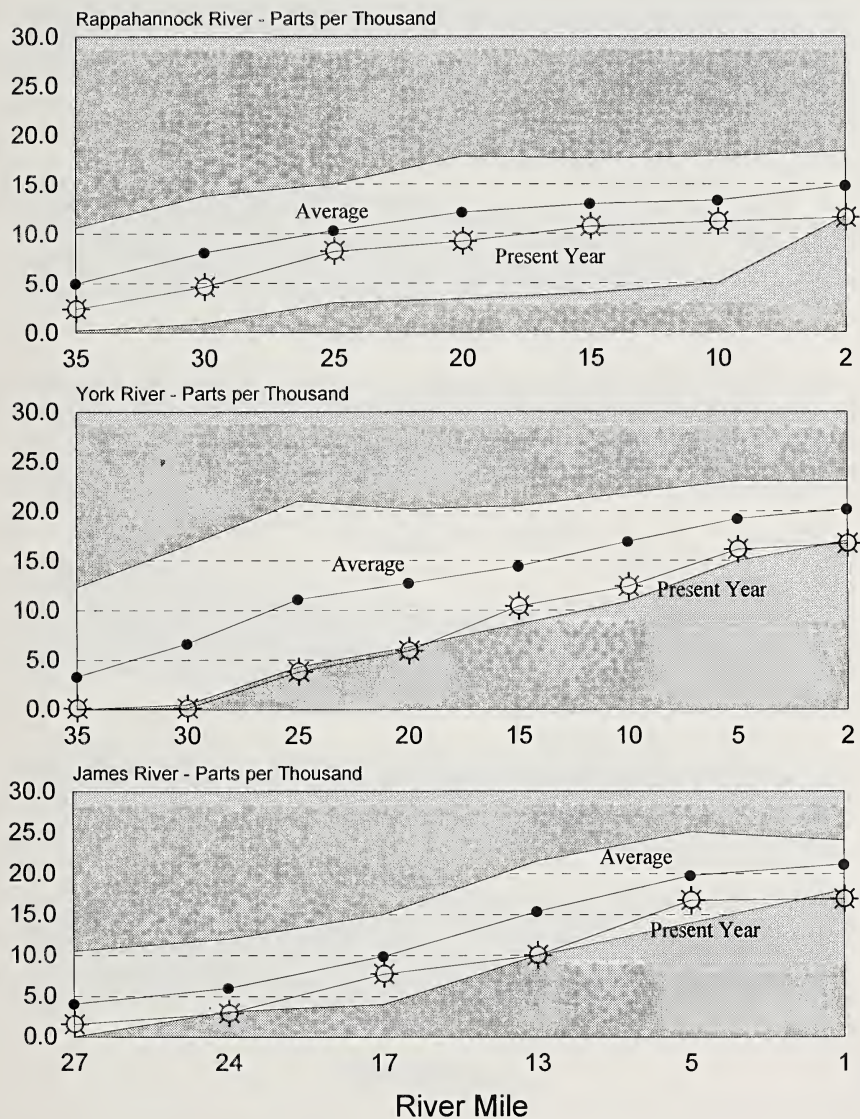


FIGURE 16a-c. Surface salinity, July 1995.

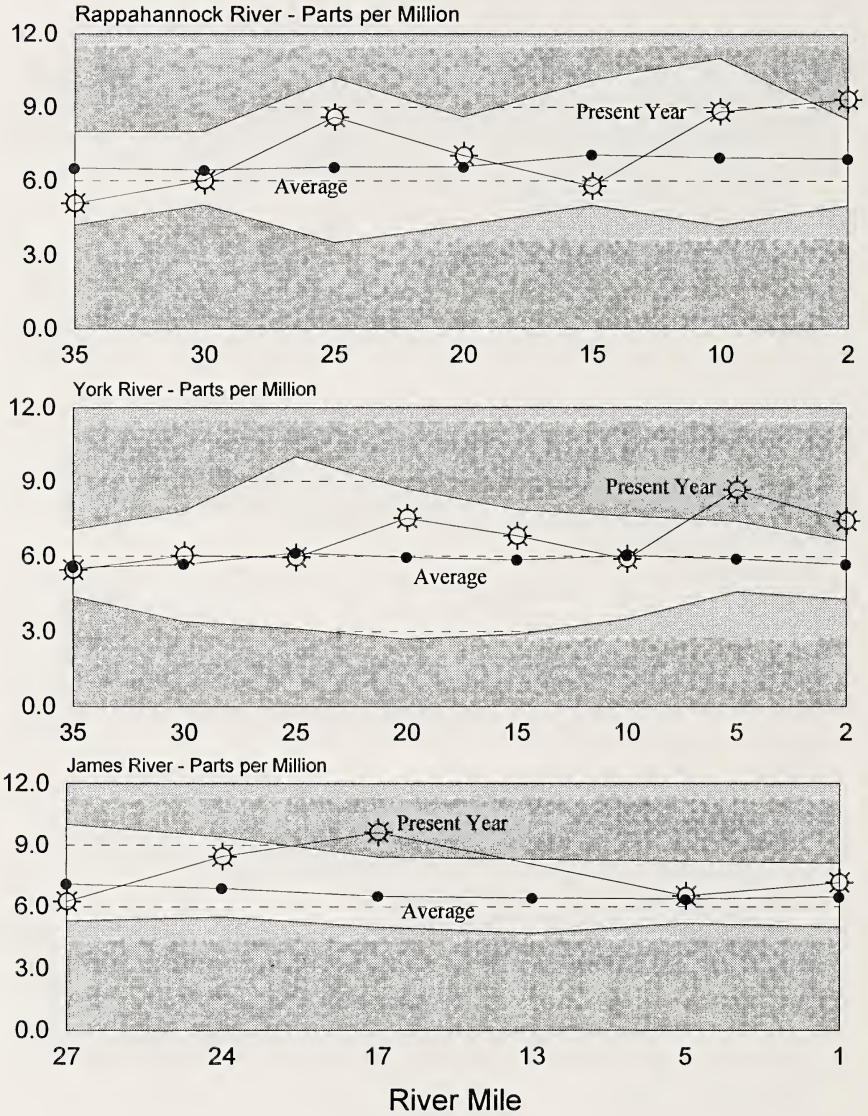


FIGURE 17a-c. Surface dissolved oxygen, July 1995.

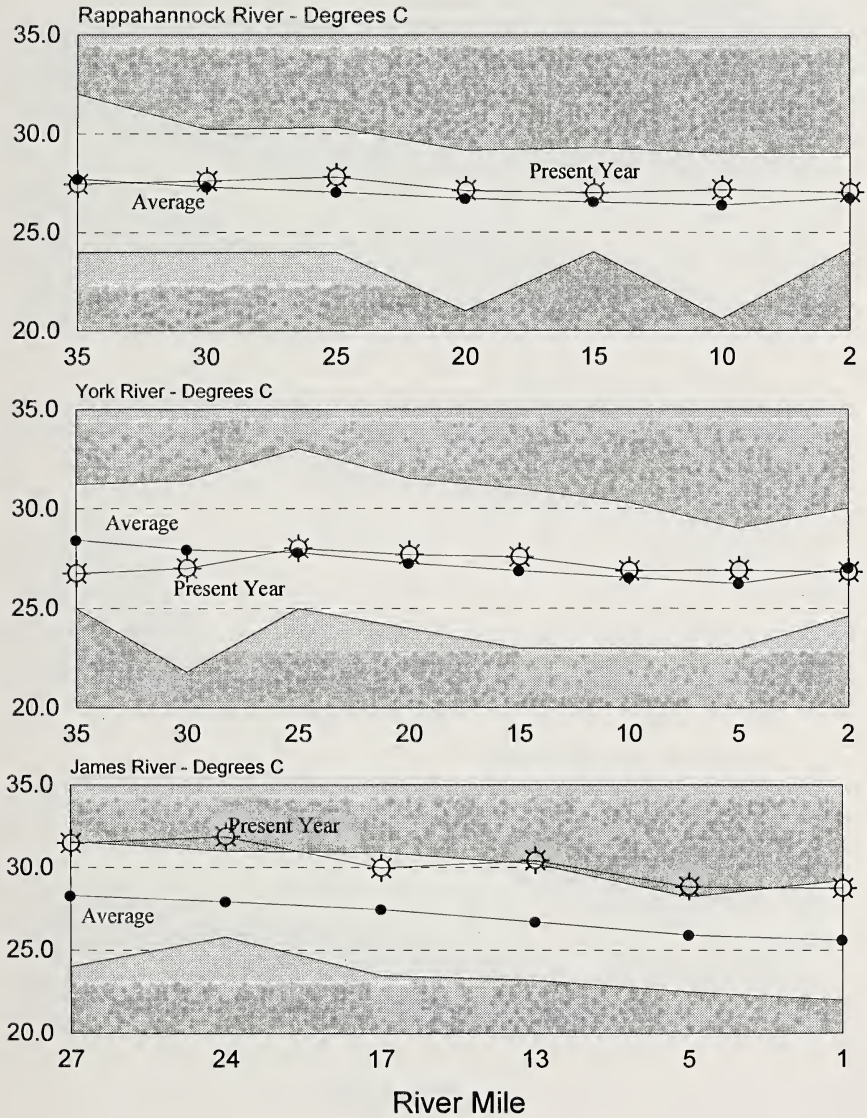


FIGURE 18a-c. Surface water temperature, July 1995.

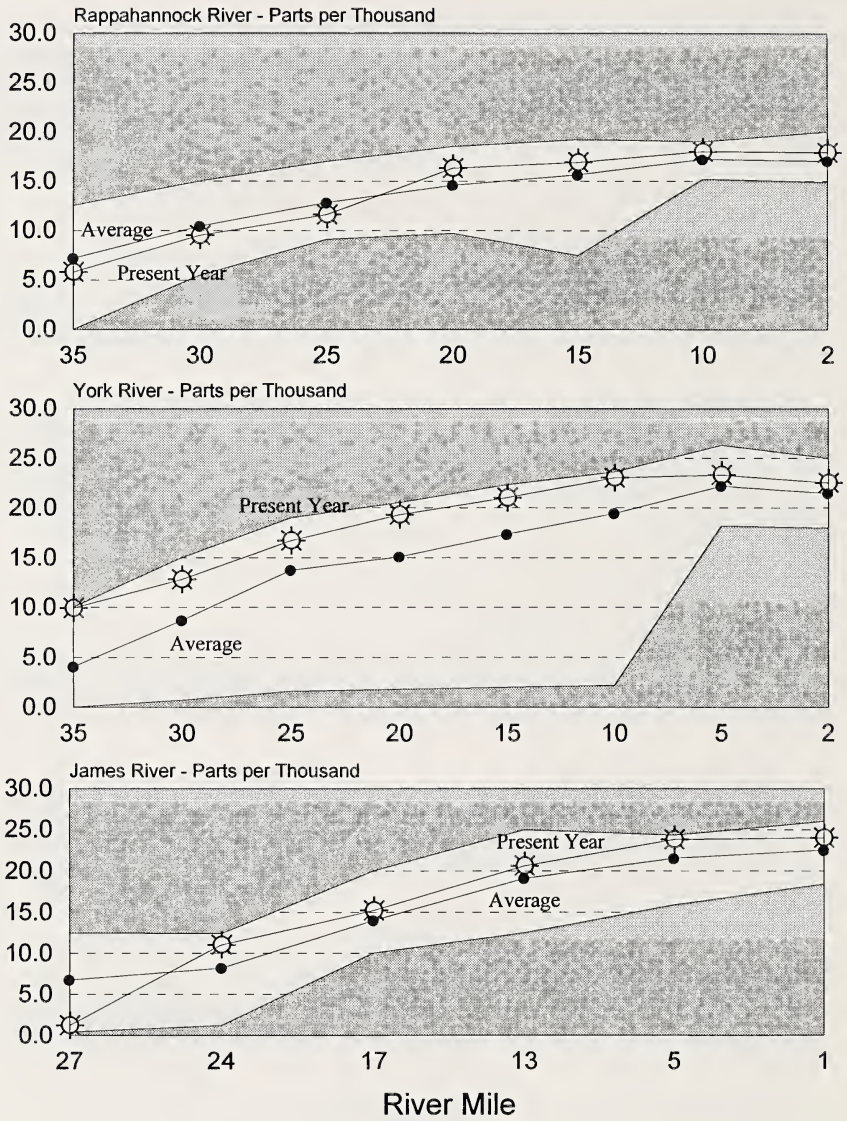


FIGURE 19a-c. Bottom salinity, August 1995.

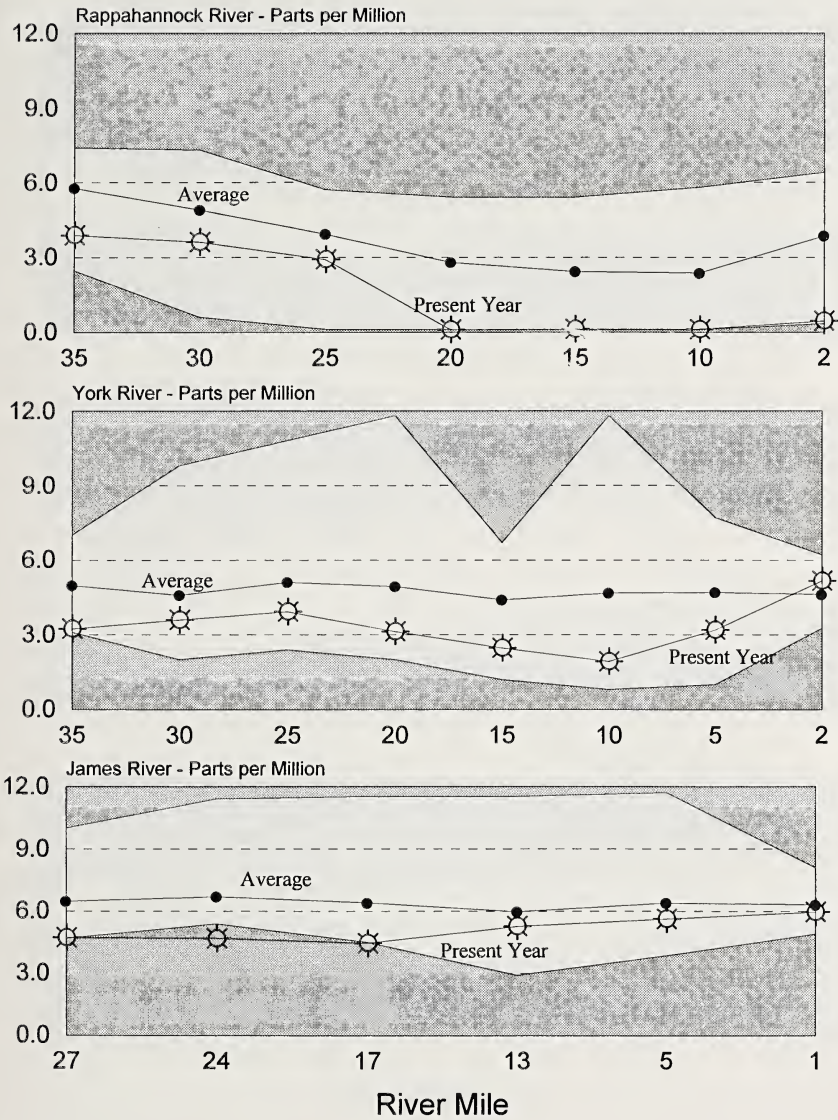


FIGURE 20a-c. Bottom dissolved oxygen, August 1995.

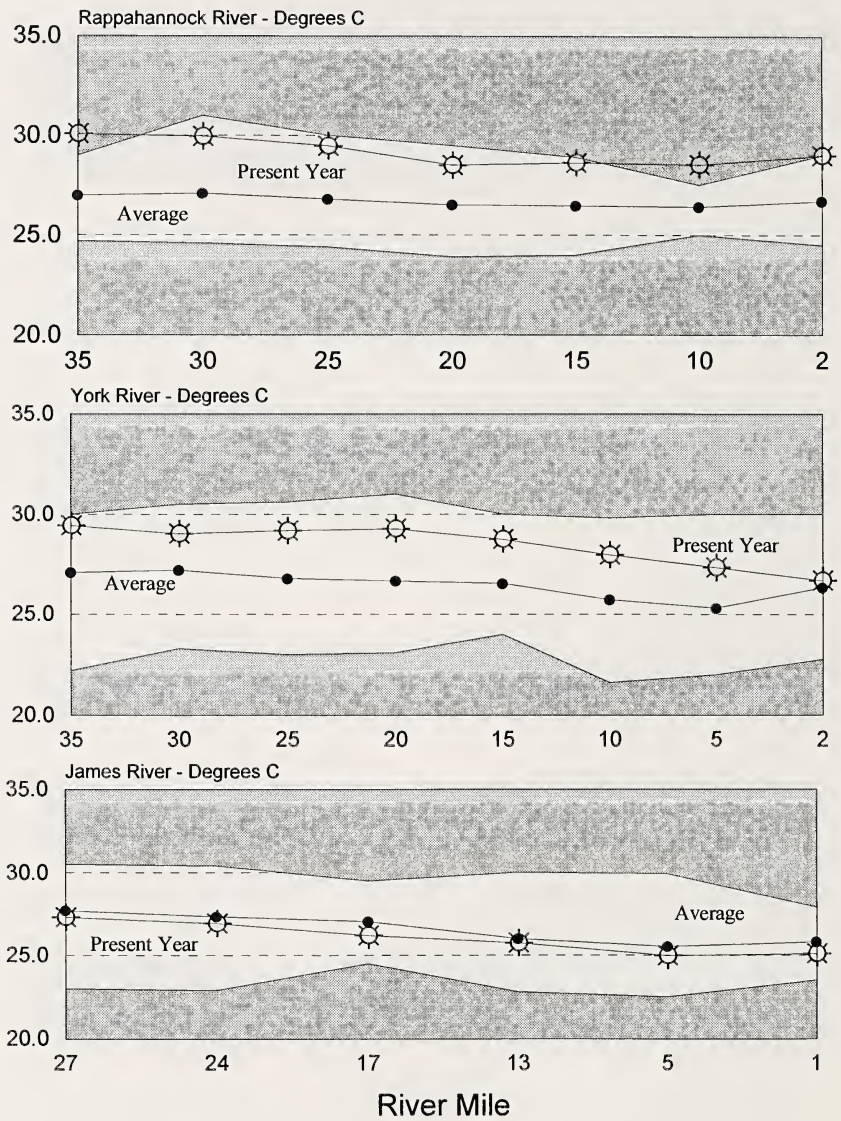


FIGURE 21a-c. Bottom water temperature, August 1995.

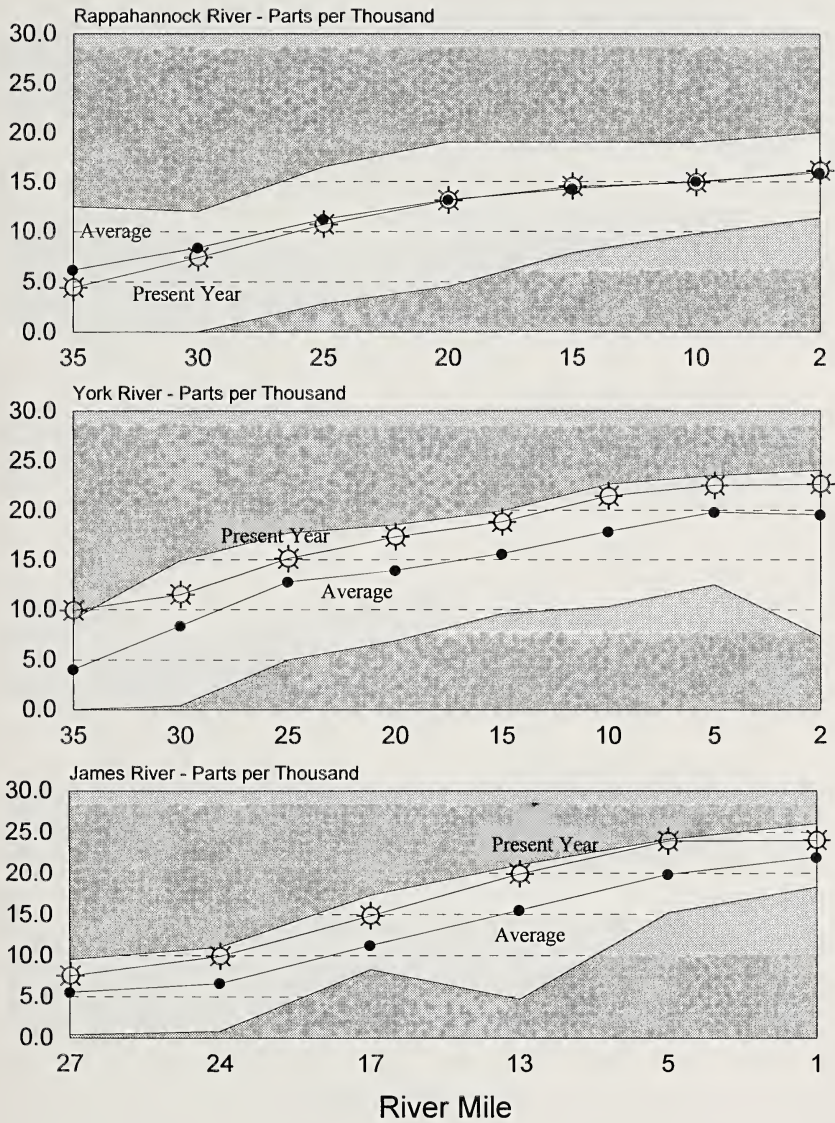


FIGURE 22a-c. Surface salinity, August 1995.

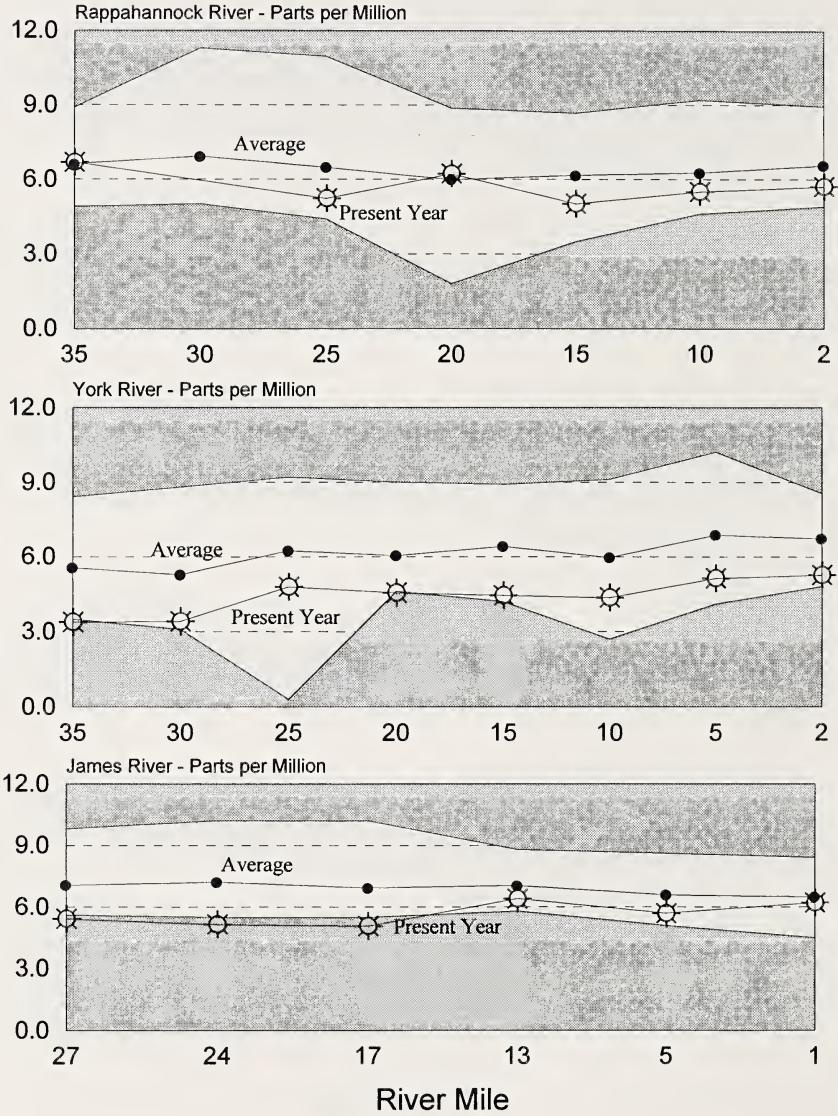


FIGURE 23a-c. Surface dissolved oxygen, August 1995.

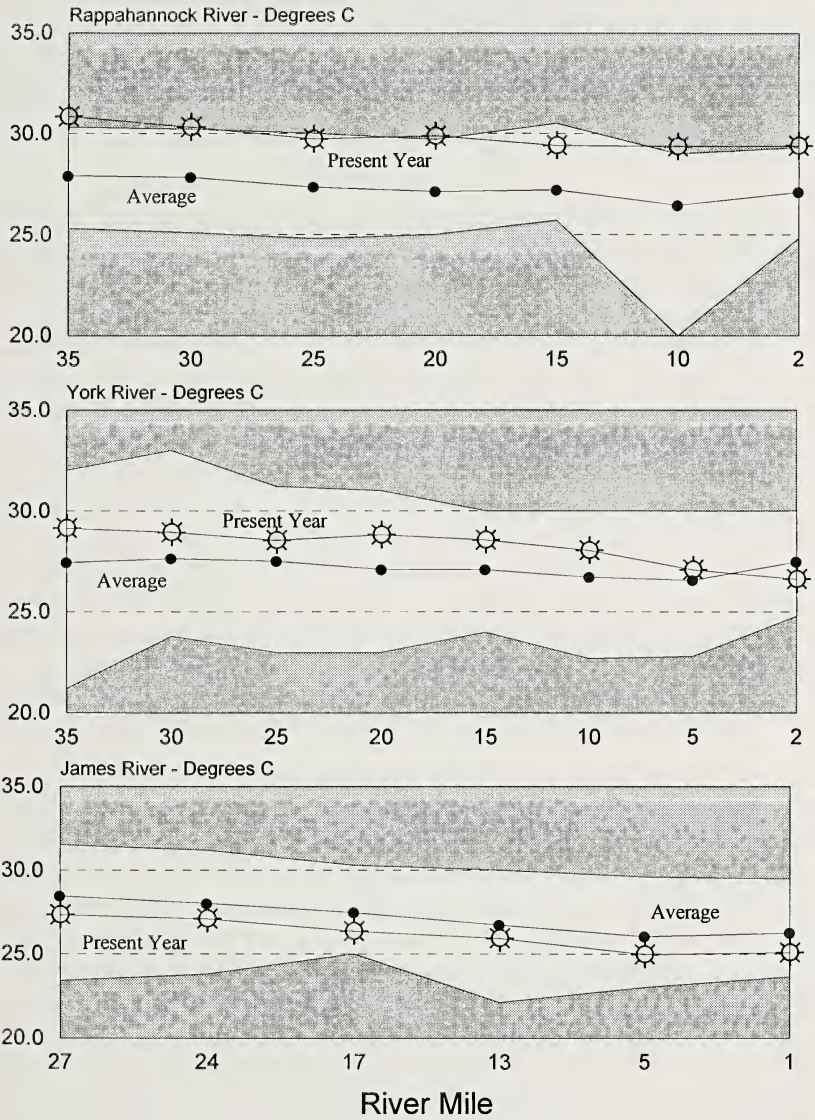


FIGURE 24a-c. Surface water temperature, August 1995.

Wildflowers as an Alternative for Landfill Revegetation in Spotsylvania County, VA

Mara Sabre, Karen D. Holl and John Cairns, Jr.¹

Department of Biology, Virginia Polytechnic Institute and
State University, Blacksburg, VA

ABSTRACT

As landfills become widespread and conspicuous components of the landscape, communities are increasingly trying to make them an asset rather than a liability. Ecological, financial, regulatory, and social concerns influence the choice of plants for revegetating landfills. In Spotsylvania County, part of the closed landfill was seeded with wildflowers to create a more aesthetically pleasing landscape than the standard revegetation mixture currently used. This study compared vegetative cover and species richness and composition in areas seeded with the wildflower and standard mixtures. Over a period of 2 years, 15 of the 19 species of wildflowers and all 9 species of the standard mixture became established. Cumulative species richness was higher in wildflower plots, whereas the number of species observed on individual sampling dates was similar in plots seeded with both mixtures due to the number of colonizing species in all plots. Vegetative cover did not differ significantly in areas seeded with the two mixtures. This study shows that, by using a range of criteria including erosion control, cost, and aesthetic and ecological value, a number of native and naturalized wildflower species compare favorably with species commonly used for landfill revegetation.

INTRODUCTION

Landfilling is a common means of disposing of household nonhazardous waste. As growth in the human population has resulted in the generation of increasing amounts of solid waste, city and county governments are confronted more often with the escalating costs of landfill construction, operation, and closure. Municipal landfills pose numerous environmental and social problems. Byproducts of anaerobic decomposition in landfills can contaminate surrounding soil and water supplies if not properly contained and monitored (Booth and Vagt, 1990; Flower et al., 1981). The anaerobic decomposition processes in landfills generate offensive odors while a landfill is in operation and afterwards, and trash from the landfill may blow offsite despite efforts to keep material in place. The environmental contamination, the odors, and misplaced trash affect people living near landfills, and property values in the area often decrease as a result. Optimally, landfills should be located out of public view; however, today, the appropriate geological and hydrological parameters necessary to site landfills are usually located near population centers. Consequently, community officials are attempting to make landfills assets rather than visual or environmental liabilities.

1 Author to whom correspondence should be addressed.

Research on landfill processes has focused on the effects of landfill leachate and gases on plants used to revegetate landfills. This research has evolved because, when a landfill is closed, it must be capped with an appropriate soil or geotextile membrane liner and seeded with fast growing vegetation to stabilize the liner (Figure 1). Most of the literature concerning landfill revegetation suggests that a mixture of quick growing annual and perennial grasses and perennial legumes be used to stabilize soil (Ettala et al., 1988; Gilman et al., 1985). Recommended plants are all hybrid, non-native species that have been particularly effective in suppressing colonizing woody species on roadside embankments and surface mined sites (Luken, 1987; Wade, 1989); in Virginia, commonly used species include *Festuca arundinacea* (Kentucky-31 tall fescue), *Lespedeza cuneata* (sericea lespedeza), and *Coronilla varia* (crown vetch) (see Table 1 for a complete list). The standard revegetation species succeed within a few years to a monoculture of *C. varia* or *L. cuneata*, which provide little wildlife value.

The municipal landfill (Chancellorsville Landfill) located in Spotsylvania County in central Virginia is an illustration of an innovative solution to the multiple constraints of landfill closure. The director of public works was confronted with the task of creating an attractive landscape on a 3.8 ha (9.4 acre) landfill. The landfill was in operation from the mid-1970s until its closure in 1992. Secondary roads now encircle the landfill, and the northwestern portion of the landfill site is less than a kilometer from residential housing. In addition, old railroad tracks that have been designated as part of the statewide "Rails to Trails" project run alongside the landfill. In an effort to create a more aesthetically pleasing landscape, the Board of Supervisors of Spotsylvania County approved money to plant wildflowers over part of the landfill. As the operator was concerned whether wildflowers would provide sufficient cover to retain the soil and maintain the integrity of the cap liner, he chose a shallow slope to seed as a trial study. The steeper slopes were seeded with a standard revegetation mixture.

The objectives of the present study were to compare vegetative cover and species richness and composition over time in each mixture type. In combination with a cost analysis, these data serve to determine if the wildflower seed mixture is a viable alternative to the standard revegetation mixture.

MATERIALS AND METHODS

The Chancellorsville Landfill is a 3.8 ha (9.4 acre) nonhazardous solid waste disposal area near Fredericksburg, Virginia (N 38° 16.3', E 77° 32.7'). The landfill was closed in April 1992 using the capping design illustrated in Figure 1. The soil used in the capping layer was excavated when the landfill was constructed. Seeding of the capped landfill was completed in July 1992. Areas with 3:1 (33%) slopes were seeded with a standard revegetation mixture. The southwestern-facing portion of the landfill with a 4:1 (25%) slope was seeded with a "Northeastern" mixture of wildflowers prepared by Applewood Seed Company. This seed mixture was comprised predominantly of species native and naturalized to Virginia. We define native as species present in Virginia prior to European colonization. The term naturalized refers to species that, while not native to Virginia, are a well-established component of the flora and do not aggressively compete with native species. Scientific and common names for all species are listed in Table 1 (hereafter, species are referred to by their scientific names only). Both mixtures were hydroseeded by spraying a mixture of seeds, paper mulch, N:P:K fertilizer, and water.

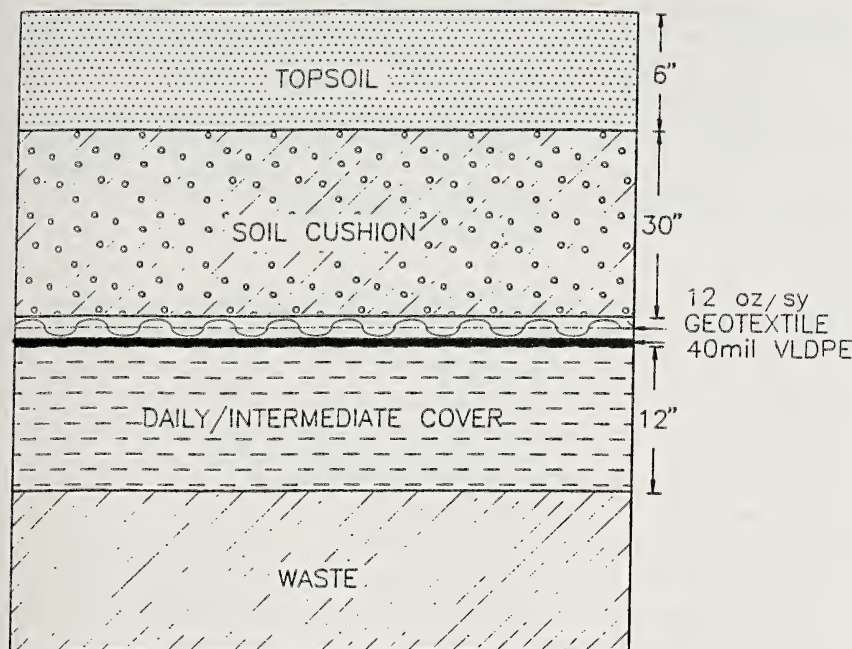


FIGURE 1. Soil cap design used at the Chancellorsville Landfill (courtesy of Draper Aden and Associates).

The hydroseed tank was not rinsed before the wildflower mixture was added, and parts of the area sprayed with the wildflower mixture included residual seeds from the standard revegetation mixture. The standard revegetation mixture was seeded at a density of 12 kg (~26 lbs) per acre, and the wildflower mixture was seeded at a density of 9 kg (~20 lbs) per acre. The difference in seeding rates was due to the higher cost of the wildflower mixture. No straw cover or additional irrigation was provided.

The southwestern aspect was chosen for study because both mixtures were represented. Four 80 m (~248 ft) transects, separated by 10 m (~31 ft), were established along the length of the same hillface. Two transects each were located in areas revegetated with the wildflower mixture (4:1 slope) and the standard mixture (3:1 slope). Eight permanent markers were placed at 10-m intervals along each transect for surveys. The total percent cover and percent cover of individual species were recorded in 1 m² (9ft²) plots at each marker three times between April and September in both 1993 and 1994. Cover was estimated by the amount of area a plant shaded within the sampling unit. Plants were identified using specimens from the Virginia Polytechnic Institute and State University (Virginia Tech) Herbarium.

Species richness and cover were compared using t-tests, considering the 16 plots of each seeding mixture as replicates. Repeated measures analysis of variance was used to determine if the main effects of time and mixture type or the related interaction was significant across both pairs of transects. Repeated measures testing was required because the same experimental unit was repeatedly sampled over time (Meredith and Stehman, 1991). Throughout, results in which $p < 0.05$ are reported as significant.

TABLE 1. Plant species inventory at the Chancellorsville Landfill in 1993 and 1994. Values are the number of survey plots in which each species was observed in each year. Values are from a total of 16 plots for the standard and wildflower species and from a total of 32 plots for colonizing species, since most of these species were observed in plots seeded with each of the mixtures. P indicates that the species was not observed in study plots but was observed elsewhere on the landfill.

LATIN NAME	COMMON NAME	No. of plots 1993	No. of plots 1994
STANDARD MIXTURE TRANSECTS (16 plots total)			
<i>Agrostis alba</i>	Red top	0	1
<i>Coronilla varia</i>	Crown vetch	4	8
<i>Festuca arundinacea</i>	Kentucky-31 fescue	16	9
<i>Lespedeza cuneata</i>	Sericea lespedeza	4	11
<i>L. stipulacea</i>	Korean lespedeza	9	11
<i>Lolium multiflorum</i>	Annual rye	1	0
<i>L. perenne</i>	Perennial rye	16	13
<i>Secale cereale</i>	Abruzzi rye	1	0
<i>Setaria italica</i>	German foxtail millet	6	0
NORTHEASTERN MIXTURE TRANSECTS (16 plots)			
<i>Aquilegia canadensis</i>	Eastern columbine	0	0
<i>Aster novae-angliae</i>	New England aster	4	1
<i>Bouteloua gracilis</i>	Buffalo grass	7	14
<i>Centaurea cyanus</i>	Cornflower	3	0
<i>Cheiranthus allonii</i>	Wallflower	3	0
<i>Chrysanthemum maximum</i>	Shasta daisy	8	1
<i>Coreopsis lanceolata</i>	Lance-leaved coreopsis	16	16
<i>Dianthus barbatus</i>	Sweet William pink	14	14
<i>Digitalis purpurea</i>	Foxglove	P	0
<i>Echinacea purpurea</i>	Purple coneflower	P	P
<i>Gypsophila elegans</i>	Baby's breath	4	0
<i>Hesperis matronalis</i>	Dame's rocket	0	10
<i>Linaria maroccana</i>	Spurred snapdragon	0	0
<i>Linum grandiflorum rubrum</i>	Scarlet flax	0	0
<i>Lupinus perennis</i>	Perennial lupine	P	0
<i>Oenothera missourensis</i>	Dwarf evening primrose	P	P
<i>Papaver rhoeas</i>	Poppy	0	0
<i>Rudbeckia hirta</i>	Black-eyed Susan	10	6
<i>Silene armeria</i>	Catchfly	1	1
COLONIZING SPECIES* (32 plots)			
<i>Ambrosia artemisiifolia</i>	Ragweed	24	18
<i>Bidens polylepis</i>	Beggar tick	13	0
<i>Cassia nictitans</i>	Wild sensitive plant	3	2
<i>Dactylon</i> sp.	Crab grass	12	9
<i>Holcus lanatus</i>	Velvet grass	1	1
<i>Hypericum perforatum</i>	St. John's wort	1	2
<i>Medicago sativa</i>	Alfalfa	4	3
<i>Phleum pratense</i>	Timothy	2	2
<i>Rosa multiflora</i>	Multifloral rose	4	4
<i>Rumex acetosella</i>	Sheep sorrel	2	2
<i>R. obtusifolius</i>	Sorrel	2	2
<i>Solidago</i> spp.	Goldenrod	0	2
<i>Trifolium arvense</i>	Rabbit's foot clover	4	4

*Colonizing species include all species that were not seeded on the landfill. They comprise a mixture of native, naturalized, and non-native species.

TABLE 2. Soil nutrients. Values are in mg/kg and are means \pm 1 SE. N = 3 samples per transect.

Transect	pH	P	K	NO ₃ -N	Ca	Mg	SS
Standard 1	6.8 \pm 0.3	6.0 \pm 2.7	63.0 \pm 31.0	3.7 \pm 1.2	592 \pm 97	77.3 \pm 8.6	55.3 \pm 15.0
Standard 2	6.4 \pm 0.3	3.7 \pm 1.2	55.7 \pm 11.0	3.7 \pm 1.2	492 \pm 87	70.3 \pm 4.6	46.7 \pm 7.5
Wildflower 1	6.9 \pm 0.4	13.3 \pm 6.1	55.7 \pm 14.0	3.7 \pm 1.2	1036 \pm 148	98.3 \pm 9.5	93.7 \pm 14.0
Wildflower 2	6.6 \pm 0.3	6.3 \pm 3.2	56.7 \pm 17.0	4.3 \pm 1.2	788 \pm 363	86.0 \pm 25.0	64.0 \pm 23.0

Soil samples were collected in 1994 from the upper 8 cm (3.1 in.) of the soil cap at three randomly located points of each of the four transects to provide baseline information for the vegetation data collected. Samples were analyzed for pH and macronutrients (P, K, NO₃-N, Ca, Mg, SS) at the Virginia Tech Soil Testing Laboratory. Soil nutrient data were pooled for each transect, and the mean values were compared within and between seed mixture types using t-tests.

RESULTS

Levels of all soil nutrients on the landfill were within ranges acceptable for growth (Table 2), although the level of nitrate nitrogen was low, 3-5 mg/kg (Brady, 1990). None of the measured nutrient levels differed significantly between paired transects nor between mixture type for any nutrient, suggesting that the soil nutrients were relatively homogeneous across the study area. Although Ca and soluble salts averaged higher levels in the wildflower plots, the differences were not statistically significant due to high variance.

Plant species observed in 1993 and 1994 in the survey plots are listed in Table 1. Eleven of the 19 wildflower species seeded were recorded on survey plots. Four additional species, including *Digitalis purpurea*, *Echinacea purpurea*, *Lupinus perennis* and *Oenothera speciosa*, were observed on the landfill but not in the survey plots. Only four of the wildflower species seeded, *Aquilegia canadensis*, *Linaria maroccana*, *Linum grandiflorum rubrum* and *Papaver rhoeas*, were not observed on the landfill. Two wildflower species, *Coreopsis lanceolata* and *Dianthus barbatus*, appeared at the highest frequency both years, being found on 16 and 14 plots, respectively. Five species, including *Centaurea cyanus*, *Cheiranthus allonii*, *Digitalis purpurea*, *Gypsophila elegans*, and *Lupinus perennis*, were observed in the first but not the second year of the study. All nine of the standard mixture species seeded were observed in survey plots in both years. *Festuca arundinacea* and *Lolium perenne* were the dominant species. Three species, *Agrostis alba*, *Lolium multiflorum*, and *Secale cereale*, were only observed in one plot in one year.

A total of 17 and 20 species (including both seeded and naturally colonizing species) was observed during the 2-year study period on the two wildflower transects, while 16 and 15 species were observed on the two standard mixture transects. Nine species naturally colonized in areas seeded with the wildflower mixture, and 11 species naturally colonized areas seeded with the standard mixture. The most common colonizing species was *Ambrosia artemisiifolia*. Most other colonizing species were widespread, non-native species.

On individual sample dates, species richness was slightly higher in the plots planted with the wildflower mixture, but it was significantly higher only in April 1994.

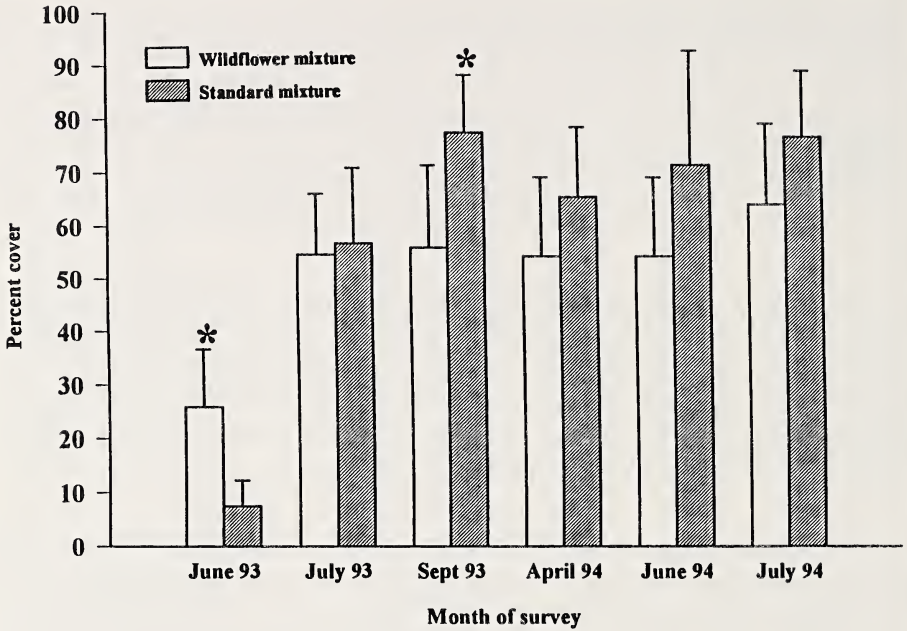


FIGURE 2. Average plant species richness on individual sampling dates for wildflower and standard mixture plots. $N = 16$ for each mixture. (*Means are significantly different at the $p = 0.05$ level using a t-test.)

Average species richness was highest in June 1993 in both mixtures (nine species) and declined in July and September (Figure 2). In 1994, species richness in the areas planted with the wildflower mixture increased from the previous September, but never recovered to the same level as the number recorded in June 1993. The number of species in plots planted with the standard revegetation mixture increased after an initial drop between June and July 1993. At the end of the survey, species richness was nearly the same in areas seeded, as a number of wildflower species were no longer present.

Total cover in the two areas ranged from 7.5-100% during the study; cover values were lowest at the initiation of the study. Cover was slightly higher in the plots planted with the standard revegetation mixture throughout the survey period (Figure 3), but it was only significantly higher than the wildflower mixture in June and September 1993. Cover of individual plots seeded with the standard mixture was sometimes the same or lower than that of the wildflower mixture plots, as there was high variability in vegetative cover in areas seeded with both mixtures. Cover for the areas seeded with the wildflower mixture remained at approximately the same level throughout the study, rising slightly in July 1994. The wildflower mixture cover increased with time during the two growing seasons. The standard revegetation mixture increased in the middle of the first growing season and decreased toward the end of the second growing season (Figure 3). Cover of naturally colonizing species ranged from 0-80% and increased overall during the 2 years of the study. Cover of naturally colonizing species was highly variable between plots seeded with the same mixture and was not significantly different in wildflower and standard mixture plots.

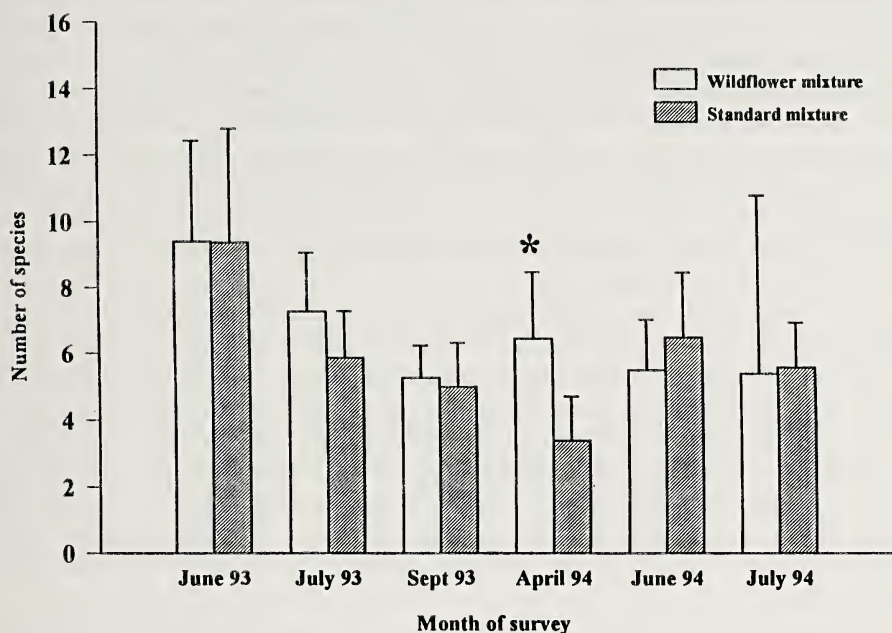


FIGURE 3. Average plant cover on individual sampling dates for wildflower and standard mixture plots. $N = 16$ for each mixture. (*Means are significantly different at the $p = 0.05$ level using a t-test.)

The total cost of the wildflower mixture seeded at 9 kg (~20 lb) per ha and of the standard mixture seeded at 12 kg (~26 lb) per ha was \$1235.00 (\$500.00/acre) each. The cost per hectare of the four absent wildflower species was \$247.00 (\$100.00/acre), 20% of the total cost of the wildflower mixture. The cost of the two dominant species of the wildflower mixture, *Coreopsis lanceolata* and *Dianthus barbatus*, was \$89.00/ha (\$36.00/acre), only 7% of the total cost of the mixture.

DISCUSSION

Communities such as those in Spotsylvania County, VA, are increasingly recognizing the benefits of revegetating landfills with native and naturalized species. Use of wildflowers for landfill revegetation is currently limited by concerns about their low establishment rates and the high cost of purchasing these seeds. This study has demonstrated that several wildflower species seeded at the Chancellorsville Landfill constitute viable alternatives to the non-native species currently used. Despite suboptimal growing conditions present at this site, performance of the wildflowers did not differ significantly from the standard mixture species with regard to erosion control, aesthetic value, ecological value, and cost.

Many landfill operators are hesitant to use native and naturalized species because of fear of increased erosion. Using aboveground cover as an indication of erosion control, the wildflower mixture compared favorably with the standard mixture. At only one of six sampling dates was cover significantly higher in standard mixture plots, despite the fact that the standard mixture was seeded at a higher rate. Most importantly,

the landfill operator was satisfied with the cover provided by the wildflower mixture during the course of the study. As state solid waste management guidelines do not specify an adequate quantity of vegetative cover for different slopes, the landfill operator must decide what is an acceptable amount. It is doubtful that cover alone is an accurate indicator of soil retention on slopes (Torbert and Burger, 1992). However, visual examination of aboveground cover is the most common method of determining whether an area is stabilized. Results of this study do not guarantee that either plant mixture will stabilize the cap without substantial soil loss; the results only indicate that the wildflower mixture is comparable to the standard mixture for aboveground cover over the 2 years of the study.

Cost is commonly the overriding criterion in choosing a revegetation protocol. A major reason for seeding aggressive, non-native species in disturbed areas is that they are often less expensive than native and naturalized species. If seeding rates had been equivalent in this project, the wildflower mixture would have been only 20% more expensive than the standard mixture. This difference in cost could be easily reduced by removing a few of the species that did not establish well on the site and replacing them with appropriate species. It is important to note that these costs are estimates; seed prices may vary greatly with company and year. Regardless, it appears that wildflowers are an economically viable revegetation alternative in the southeastern United States.

While difficult to quantify, aesthetic value is an important factor in the public's acceptance of disturbed areas such as landfills. Based on observations by the landfill operators and scientists, the sections seeded with wildflowers were more visually pleasing. By the end of the survey, the color display in the wildflower section was dominated by the yellows of *Bidens* spp., *Coreopsis lanceolata*, and *Rudbeckia hirta*. For the operator, the areas seeded with wildflowers contrasted favorably with the standard mixture areas and the surrounding meadow. If the standard revegetation mixture had provided an adequate view from the outset, then the landfill operator would not have invested time, money, and resources in trying an alternative mixture.

As with aesthetic value, quantification of the ecological value of plants is difficult and largely subjective. Unfortunately, regulations do not consider floristic composition as a factor in selecting revegetation covers. Species richness overall was slightly higher on plots seeded with the wildflower mixture, which is not surprising since more wildflower species were seeded. On individual sampling dates, species richness was similar in plots seeded with both wildflower and standard mixtures. This result is largely due to the high number of colonizing species occurring on both aspects, and also to the fact that most of the grasses in the standard mixture are present throughout the growing seasons while a number of the wildflower species have shorter growing seasons. For example, *Dianthus barbatus* flowers in June and rapidly senesces, while *Ambrosia artemisiifolia* grows slowly over the season until it flowers in August.

It is important to consider not only number of species but also the species composition. More of the wildflower species are either native or naturalized to the region, which suggests that they would provide more value to wildlife. For example, research on reclaimed coal surface mines in the southeastern United States has shown that animals are more commonly associated with native, naturally colonizing species than non-native, planted species on reclaimed mine sites (Brenner et al. 1984; Holl 1994). Research on landfills suggests that using wildflowers and compatible grasses

provides a stable source of seeds for consumption by birds and insects (Davis, 1989; Robinson and Handel, 1993; Smith, 1993).

Naturally colonizing species constituted an important component of the vegetation in areas seeded with both mixtures. Naturally colonizing species ranged from species native to the area (e.g., *Ambrosia artemisiifolia*) to aggressive non-native species (e.g., *Rosa multiflora*). Non-native species can be beneficial or disastrous, depending upon their aggressiveness. Species such as *Dactylon* sp. commonly outcompete native species and form monocultures over large areas. Despite the reputation of the standard revegetation mixture to better resist colonization of aggressive weeds, the number of colonizing species (predominantly non-native) and percent cover of these species were similar in wildflower and standard mixture plots.

If left unmanaged, the wildflowers that were seeded would eventually be succeeded by woody vegetation. However, the Spotsylvania Landfill, as in many landfills in Virginia, is mowed towards the end of the growing season to prevent the establishment of woody vegetation. Legislation prohibits woody species on landfills, due to fear of the roots of woody species penetrating the landfill liner. This restriction is one of the reasons the landfill operator chose to use wildflowers to increase the vegetative diversity on the landfill. Mowing also serves to enhance growth of the wildflowers in the following year.

While the majority of wildflower species became established, a few of the seeded species were not observed on the landfill. *Centaurea cyanus*, *Echinacea purpurea*, and *Silene armeria*, which have shown high establishment rates on other disturbed sites (Sabre, 1994), were recorded in low numbers at the Spotsylvania landfill. *Papaver rhoeas*, a popular species used for roadside wildflower plantings throughout Virginia and the United States, was never observed on the landfill. The low establishment or absence of these species at the Chancellorsville Landfill may be due to the combined factors of time of seeding (July), variable germination densities, and quality of seed stock. These results highlight the importance of doing greenhouse germination studies and small-scale test plots prior to landfill seeding. Screening tests serve to identify species that have low germination or survival rates; this screening reduces the cost of the seeding mixture. Field test plots are important to identify site-specific differences in establishment rates.

Interpretation of these results should be considered in the context of three problems with the experimental design that were beyond the control of the researchers. First, as discussed previously, standard and wildflower seeds were mixed in the hydroseeder, which complicated comparing the two mixtures. Fortunately, standard revegetation species were rarely observed along the two wildflower transects, suggesting that the seed contamination was minimal. Second, the landfill seeding was done in July rather than at the normal time, spring or fall. While establishment rates may have been lower due to lack of rainfall and elevated soil temperatures, both mixtures were seeded at the same time, allowing for comparisons between mixtures. Finally, results may have been confounded by the fact that the two mixtures were seeded on different slopes. While some plant species may be affected by 8-10 degree differences in slope, most of the species used are adapted to a range of stressful conditions. Therefore, the effect of slope differences was likely minimal.

The results of this and other studies (e.g., Sabre, 1994) highlight the importance of beginning relevant planning and research at least 3-10 years before closure of a landfill

to reduce costs of soil amendments, to locate appropriate vegetation types, and to reduce the risk of erosion as a result of inadequate seeding densities or dead seed at closure. For example, New York City has spent thousands of dollars annually at the Fresh Kills Landfill, the largest in the world at 1265 ha (3000 acres), to determine how the landfill might best serve the community when it closes in 20-30 years (Robinson and Handel, 1993). While the expenses of analyzing soil nutrients and establishing plots to test revegetation protocols increase the cost of restoration efforts over the short term, they will result in increased chances of success and reduced costs over the long term. In addition, it is important to include long-term monitoring as an integral component of any revegetation effort. The large turnover of species observed in the 2 years of this study demonstrates the need to monitor revegetation projects for a number of years in order to judge success and correct any problems that may arise.

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Abundance of Adult *Ixodes scapularis* and Infection with *Borrelia burgdorferi* in Eastern Virginia

Michael Casteel and Daniel E. Sonenshine

Department of Biological Sciences, Old Dominion University,
Norfolk, Virginia 23529

ABSTRACT

Field studies to determine the relative abundance of adult blacklegged ticks, *Ixodes scapularis* and rates of infection of adult ticks with *Borrelia burgdorferi* were done in three localities in eastern Virginia. At the time of the Fall seasonal peak, tick capture frequency was greatest, $(37.5 \pm 4.3 \text{ (S.E.) ticks/100 minutes})$, on Assateague Island (Chincoteague National Wildlife Refuge), a peninsula along the Atlantic Ocean near the Maryland border. Tick capture frequency was considerable lower, $(21.7 \pm 5.3 \text{ (S.E.) ticks/100 minutes})$, at the Cheatham Annex Naval Supply Station, an inland locality near Williamsburg. Ticks were virtually absent at the Back Bay National Wildlife Refuge, a coastal locality in southeastern Virginia near the North Carolina border. Rates of *Borrelia burgdorferi* infection in adult ticks were similar at the Assateague Island (7.7%) and Cheatham Annex sites (9.1%). No evidence of infection was found in the two ticks examined from Back Bay.

Key words: Blacklegged tick, *Ixodes scapularis*, abundance, *Borrelia burgdorferi*, infection, Lyme borreliosis.

INTRODUCTION

First described in 1977 (Steere et al., 1977) Lyme disease is now considered the most prevalent vector-borne disease in humans in the United States. The disease is caused by a spirochete, *Borrelia burgdorferi* Johnson, Schmid, Hyde, Stierwalt and Brenner, which is transmitted by the bite of a black-legged tick, *Ixodes scapularis* Say. Thousands of cases have been reported in the United States each year (Anon., 1993). Although the numbers of cases of Lyme disease that occur in the southeastern states are not as high as in the northeastern and north central regions of the United States (Ginsberg, 1993; Luckhart et al., 1991; Amerasinghe et al., 1993), the number of cases from the former region have increased greatly since the 1980's. In Virginia, case numbers of Lyme disease for 1992, 1993 and 1994 which met the case definition of the Center for Disease Control and Prevention (Atlanta, GA) were 115, 95 and 131, respectively. According to the Virginia State Health Department, the risk of infection for humans is greatest in the eastern part of the state, especially the northeastern and coastal counties. Studies of ticks and wildlife native to Virginia demonstrated that *B. burgdorferi* occurs in wildlife and ticks (Levine et al., 1991; Sonenshine et al., 1995). *B. burgdorferi* was isolated (and cultured) from 5 species of small mammals in a coastal site near Chincoteague and an inland site between Williamsburg and Yorktown. In addition, *B. burgdorferi* infection was demonstrated by immunofluorescence assay in ticks, mostly *I. scapularis* in these same localities (Sonenshine et al., 1995). These

reports suggest that Lyme borreliosis (i.e., spirochete infection in wildlife and ticks) is established in eastern Virginia. However, most of the evidence concerning infection in *I. scapularis*, the major vector, was based on immature ticks collected from vertebrate hosts. Few records were obtained from unfed adult black-legged ticks.

Although nymphal black-legged ticks are considered to be the most important vectors of *B. burgdorferi* to humans (Lane *et al.*, 1993), adult ticks also represent a serious threat to hunters, hikers and other people enjoying outdoor recreational activities in the fall and early spring. In the northeastern United States, *I. scapularis* is abundant and rates of natural infection in unfed adults frequently range from 20 - 100% (Burgdorfer *et al.*, 1982; Anderson, 1989). Consequently, the risk of human infection from contact with unfed adults in that region is considerable. Less is known about *I. scapularis* abundance or rates of *B. burgdorferi* infection in adult ticks in the southeastern part of the United States. In Virginia, rates of infection in *I. scapularis* adults, based on small sample numbers, were 23.5% near the coast (Chincoteague) and 0.2% 64 kilometers inland (Williamsburg/Yorktown). Elsewhere in the southeastern region, reports of natural infection in adult *I. scapularis* ranged from 1 - 3% (Magnarelli *et al.*, 1986; Luckhart *et al.*, 1991). No estimates of adult *I. scapularis* abundance in this region have been reported.

Knowledge of tick abundance and *B. burgdorferi* infection rates are important for defining high risk areas for Lyme disease. Consequently, this study was undertaken to compare the relative abundance of adult, unfed *I. scapularis* and to determine infection rates of *B. burgdorferi* in this species at three contrasting localities in eastern Virginia.

MATERIALS AND METHODS

Intensive sampling for ticks was done in selected study sites in three localities in eastern Virginia between 4 October and 22 November, 1994, the period of maximum adult *I. scapularis* seasonal activity. The study sites were located at 1) Assateague Island, part of the Chincoteague National Wildlife Refuge (CNWR), adjacent to the Atlantic Ocean; 2) the Cheatham Annex Naval Supply Station (CANSS) near the York River between Williamsburg and Yorktown; and 3) at the Backbay National Wildlife Refuge (BBNWR) in Virginia Beach, with study sites located on Long Island in Backbay and on the adjacent mainland (Fig. 1). The CNWR and CANSS study sites were chosen because of their previous use for intensive field studies of small mammals, immature *I. scapularis* activity and spirochete infection studies over a three year period (Sonenshine *et al.*, 1995).

Description of Study Sites. The dominant vegetation in the CNWR study site consisted of closely-spaced bayberry bushes (*Myrica cenifera*) (most less than 3 m high) on sandy dunes, with scattered loblolly pine (*Pinus taeda*) and Virginia pine (*P. virginiana*) distributed among them. Ground cover was relatively sparse within the bayberry thickets, but masses of greenbrier (*Smilax*), thistle (*Cardus sp.*) and various vines (*Cuscuta sp.*) dominated the understory. Surrounding the thickets were grassy meadows covered predominantly by salt grass (*Distichlis spicata*) and other grasses but also containing blackberry (*Rubus cuneifolius*), greenbrier, thistle and various weeds. Brackish marshes dominated by marsh grass (*Spartina alterniflora*) were interspersed among the meadows and bayberry thickets. Further inland, about 0.5 to 1 km from the beach, there was a transition to mixed deciduous-pine second growth

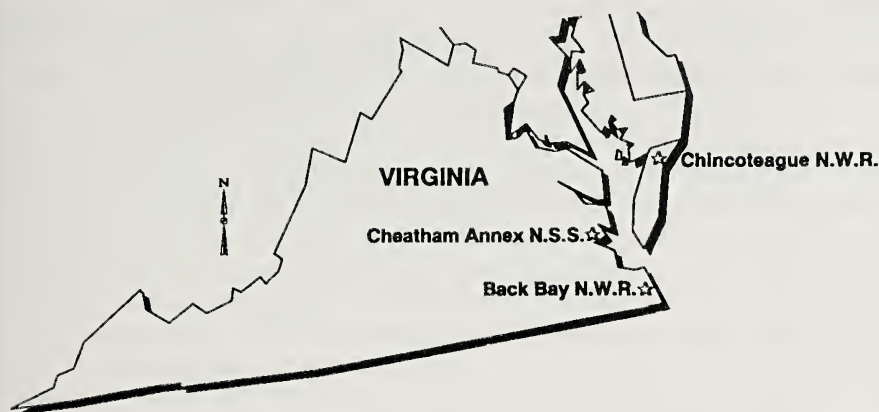


FIGURE 1. Map of Virginia showing the location of the three different study localities. Sampling at the Chincoteague National Wildlife Refuge (CNWR) was done along two transects established in or adjacent to bayberry thickets on Assateague Island, near the Atlantic Ocean. Sampling at the Cheatham Annex Naval Supply Station (CANSS) was done along four transects established in or adjacent to upland forest communities. Sampling at the Back Bay National Wildlife Refuge (BBNWR) was done along transects established in or adjacent to forest habitat.

forests dominated by loblolly pine, red maple (*Acer rubrum*), tulip (*Liriodendron tulipifera*) and white oak (*Quercus alba*) with a dense, almost impenetrable understory of blueberry (*Vaccinium crassifolium*), masses of greenbrier (*Smilax spp*) and other vines. Previous studies showed large numbers of *I. scapularis* immatures on small mammals in this habitat, but not in drier, oak-pine thickets further inland. Consequently, the adult tick sampling effort was limited to the bayberry thickets and adjacent meadows.

The dominant vegetation at the CANSS was deciduous forest, mostly white oak, loblolly pine, Virginia pine, red maple, sweet gum (*Liquidambar styraciflua*), American beech (*Fagus grandifolia*), tulip poplar and river birch (*Betula nigra*). In the understory, greenbrier, Japanese honeysuckle, Virginia creeper, blackberry and other vines were common, especially near the margins of the woodlands or along trails.

The vegetation at the BBNWR consisted of small areas of forest, mostly mixed pine and oak species, and grassy meadows (especially on Long Island). The dominant forest vegetation included Virginia live oak (*Quercus virginiana*), southern prickly ash (*Xanthoxylum clavaherculis*), sassafras (*Sassafras albidum*), loblolly pine and white swamp oak (*Quercus bicolor*) with an understory of greenbrier, other vines, bayberry, Virginia inkberry (*Ilex glabra*) and others. The dominant meadow grasses included switchgrass (*Panicum virgatum*), saltgrass and beachgrass (*Ammophila breviligulata*) interspersed with scattered shrubs. Brackish marshes were also present but were not included in the sampling areas.

Adult Tick Sampling Procedures. Ticks were collected with a one m² denim cloth tick flag attached to a 1.2 m wooden dowel as described by Sonenshine (1993). Flagging was done along measured transects selected at random (from compass bearings) for a total of 120 min (excluding time to remove ticks) at two transects at the

CNWR (Assateague Island), four at the CANSS and two at the BNWR. A stopwatch was used to record the time actually spent during flagging and to exclude the time required for examining the flag, collecting the ticks and transferring them to numbered vials. The number of ticks captured at each interval that the flag was examined was used to determine the mean number of ticks \pm S.D. captured on each sampling date. Markers were placed at regular intervals along each transect to guide the flagging process. Based on measurements of the time required to flag 10 m (13.7 ± 0.2 s, $n = 18$), the average area sampled at each of the three locations, CNWR, CANSS, and BNWR, was $5,256 \text{ m}^2$ (0.53 ha). At Assateague Island, the two transects were in the (predominantly) bayberry thickets approximately 1 km apart from one another and adjacent to the dunes that separated these habitats from the Atlantic Ocean. At the CANSS, two of the four transects were at the edge of old fields surrounded by dense woodlands; the remainder were in dense forest. At the BNWR, one of the transects was in a grassy area at the edge of wooded habitat on a small (280 ha) island; the other was in wooded habitat along the bay shore. The area sampled at each of the three locations was $5,256 \text{ m}^2$ (approximately 0.53 ha). Captured ticks were identified (species and sex), the date and site of collection recorded, and the specimens taken to the laboratory for examination. Sampling was done from 4 October to 24 November, 1994, after which the refuges were closed for deer hunting.

Laboratory Procedures. Surviving ticks were surfaced sterilized and examined for *B. burgdorferi* antigens by the immunofluorescence assay (IFA) using monoclonal antibodies H5332 and H6831 in accordance with techniques described by Bissett and Hill (1987). Ticks were surface sterilized (0.5% sodium hypochlorite, 70% ethanol), washed with phosphate-buffered saline (PBS), dissected, the midgut contents smeared onto slides and allowed to air dry. Slides were fixed in acetone (20 min), rinsed 3 X with PBS, treated with 10 μL of monoclonal antibody H5332 or H6831 (gift from Alan Barbour, University of Texas Health Center, San Antonio, TX) and incubated for 45 min at 37°C . Following staining with fluorescein isothiocyanate-labeled anti-mouse immune antibodies, the slides were covered and examined with epifluorescence microscopy at 400X with an Vanox AH2 microscope (Olympus) for evidence of spirochetes. Smears made from cultures of the B31 strain of *B. burgdorferi* were used as positive controls while smears of *B. anserina* spirochetes were used as negative controls. The control specimens were obtained from the American Type Culture Collection (Washington, D.C.).

RESULTS

Relative Abundance of *I. scapularis*. At Assateague Island, a total of 171 adult *I. scapularis* (76 males, 95 females) were collected in the two transects on six dates between 4 October and 22 November. Tick capture success at the three different study localities, expressed as the mean number of ticks \pm S.E./100 minutes, is summarized in Table 1 and in Fig. 2. The seasonal activity peak occurred on 4 November. Tick numbers captured increased from only 1.7 ± 1.0 (3.8 ticks/ha) on 4 October to 37.5 ± 4.1 ticks/100 min (85.6 ticks/ha) on 4 November. Tick numbers captured declined thereafter, down to 24.2 ± 5.6 ticks/100 min (55.2 ticks/ha) when sampling was terminated on 22 November. It is not known how much longer ticks would have remained active after sampling ended. At the CANSS, a total of 99 adult *I. scapularis*

TABLE 1. Frequency of collection and relative abundance of adult *Ixodes scapularis* at three contrasting localities in eastern Virginia.

Dates	<u>Assateague Is. (CNWR)</u>		<u>CANSS</u>		<u>BNWR</u>	
	Mean \pm S.E.	Avg. No./ha ¹	Mean \pm S.E.	Avg. No./ha ¹	Mean \pm S.E.	Avg. No./ha ¹
(1994)	Ticks/100 min.		Ticks/100 min.		Ticks/100 min.	
4 - 6 Oct	1.7 \pm 1.0	3.8	4.2 \pm 1.8	9.5	0.00	0.00
11 - 13 Oct	21.7 \pm 5.2	49.5	15.0 \pm 3.0	34.3	2.0 \pm 1.2	3.8
29 - 31 Oct	31.6 \pm 4.3	72.3	11.7 \pm 2.9	26.6	0.00	0.00
4 - 6 Nov	37.5 \pm 4.1	85.6	18.3 \pm 3.6	41.9	1.0 \pm 0.8	1.9
15 - 17 Nov	25.8 \pm 3.0	59.0	21.7 \pm 5.3	49.5	0.00	0.00
22 - 24 Nov	24.2 \pm 5.6	55.2	11.7 \pm 3.1	26.6	0.00	0.00
Mean \pm (S.E.) all samples	23.8 \pm 33.4	53.8	13.8 \pm 19.7	31.1	3.0 \pm 2.0	0.9

¹ Estimated number of ticks that would have been collected if one hectare had been sampled. Each value represents the actual number collected in each 120 min sampling period \times the conversion of sampling area 0.53 ha to 1 ha.

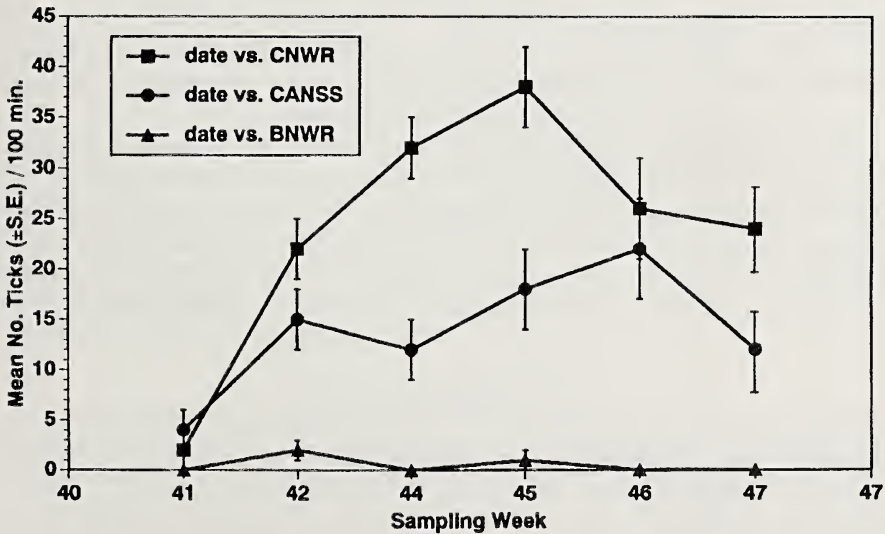
FIGURE 2. Graph illustrating adult tick (*Ixodes scapularis*) sampling success at the three different study sites in eastern Virginia during the fall, 1994 sampling period.

TABLE 2. Rates of infection of *Borrelia burgdorferi* in adult *Ixodes scapularis* at three localities in eastern Virginia.

Life stage	Assateague Is./ CNWR		CANSS		BNWR	
	No. examined	No.(%) positive	No. examined	No.(%) positive	No. examined	No.(%) positive
Males	46	3 (6.5)	41	4 (9.8)	2	0 (0)
Females	58	5 (8.6)	25	2 (8.0)	0	NA ¹
Totals	104	8 (7.7)	66	6 (9.1)	2	0 (0)

1 Not applicable.

(62 males, 37 females) were collected on approximately the same dates as above. Most of the ticks (71.7%) collected came from the forested transects. The seasonal peak occurred on 15 November when captures reached 21.7 ± 5.3 ticks/100 min (49.5 ticks/ha). At the BNWR, only three ticks were collected during the sampling period, all from the island transect. Capture success at the three different localities was significantly different from one another ($F = 13.108$, 15, 17, $p < 0.001$; 1-way analysis of variance). If the BNWR, where ticks were virtually absent, is excluded, capture success at the CNWR (Assateague Island) was significantly greater than at the CANSS ($F = 3.21$, 10, 11, $p < 0.05$, 1-way analysis of variance).

Rates of *B. burgdorferi* infection in *I. scapularis*. Infection was found in eight (7.7%) of 104 adult *I. scapularis* examined from Assateague Island (Table 2). These included three males (6.5% of 46 examined) and five females (8.6% of 58 examined). Infection was found in six (9.1%) of 66 adult *I. scapularis* examined from the CANSS, including four males (9.8% of 41 examined) and two females (8.0% of 25 examined). No evidence of infection was found in two ticks that were examined from the BNWR.

DISCUSSION

This study was the first opportunity to systematically compare adult tick relative abundance and *B. burgdorferi* infection rates in populations of *I. scapularis* in different localities of eastern Virginia. A previous study (Sonenshine *et al.*, 1995) compared larval and nymphal *I. scapularis* on wild-caught small mammals and infection rates in these immatures, but did not systematically sample adult ticks. Although limited in scope, the results of the present study suggest that *I. scapularis* is more abundant near the Atlantic Ocean, as represented by Assateague Island (CNWR) than further inland in Virginia, as represented by the CANSS. This finding is consistent with an earlier report (Sonenshine *et al.*, 1995) that found the tick to be more abundant on Assateague Island than further inland. Whether the larger *I. scapularis* population on Assateague Island is representative of the eastern coast or an isolated focus of high tick density is unknown.

Studies of *I. scapularis* occurrence in Maryland have shown that the ticks are most numerous on white-tailed deer in the eastern part of the state, near the Atlantic Ocean (Amerasinghe et al., 1992, 1993). Similarly, a four year statewide survey of ticks on white-tailed deer in North Carolina showed that 46% of all *I. scapularis* were collected in the eastern coastal plain region (Apperson et al., 1990). Thus, it is not surprising that tick relative abundance in Virginia also appears to be greater near the Atlantic Ocean than further inland. However, at Back Bay, along the southeast coast and Parramore Island, a barrier island bordering the Atlantic Ocean, *I. scapularis* was virtually absent (this paper; Levine et al. 1991; Sonenshine et al. 1995). The infrequent occurrence of *I. scapularis* on the barrier islands or coastal habitats south of Assateague Island is puzzling. White-tailed deer and small mammal hosts occur in these localities, although white-footed mice (*Peromyscus leucopus*) are absent from several of the barrier islands. However, studies on Assateague Island have shown that a variety of other small mammals can support the immature stages of this tick in the absence of *P. leucopus* (Sonenshine et al., 1995). South of Assateague Island, the vegetation changes and the waxmyrtle thickets that provide excellent tick habitats at the former locality are rare or absent on the other barrier islands. Assateague Island (actually a peninsula extending from the Maryland mainland) is more representative of eastern Maryland, where *I. scapularis* is abundant, than the Virginia barrier islands or other coastal communities. However, except for our study at the CANSS near Williamsburg, nothing is known about the occurrence of *I. scapularis* or its relative abundance on the mainland of eastern Virginia. The relatively high incidence of Lyme disease cases in Accomack county, where Assateague Island is located (189.3 cases/100,000 population for the five-year period, 1990 - 1994) (Virginia State Health Department, unpublished) suggests that *I. scapularis* may be more abundant on the mainland than on the coastal islands. This possibility should be investigated further.

Despite differences in tick abundance, infection rates in unfed adults at CNWR (7.7%) and CANSS (9.1%) were similar. This is quite different from the rates reported for immature ticks from these two localities; for nymphs collected from small mammals, the rates for the same two localities, CNWR and CANSS, were 22.1% and 0%, respectively (Sonenshine et al., 1995). Both studies support the conclusion that *B. burgdorferi* infection rates in ticks (*I. scapularis*) in eastern Virginia are substantially lower than in ticks in the northeastern United States.

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Mr. Casteel carried the field work and performed the laboratory diagnostic assay under the overall supervision of Dr. Sonenshine. Dr. Sonenshine assisted with some of the field work and wrote the manuscript.

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MARTHA ANN KOTILA ROANE

1921 - 1996

Martha K. Roane was born into a botanical heritage on November 1, 1921 at Munising, Michigan. Her father, John E. Kotila, was a potato pathologist for the Michigan Agricultural Experiment Station and her mother, Martha Olsen, had grown up on a farm. Martha attended elementary school in East Lansing. About 1932, her father was appointed Plant Pathologist with the United States Department of Agriculture at Washington, DC so Martha attended high school in the District and graduated in 1939. Thereupon, she enrolled at Michigan State College to major in botany under the guidance of E. A. Bessey. Toward the end of her B.S. program in 1943, there was a need for women in the engineering aspects of the aircraft industry. She became a fellow in the Pratt and Whitney wartime training program and was thoroughly educated in mathematics and machinery. After graduation in 1944, she was assigned to work at Hartford where she devoted time to the development of jet engines and the translation of German patents related thereto. At war's end, she enrolled in the University of Minnesota Department of Plant Pathology where she worked on the late blight disease of potato under the direction of E. C. Stakman and C. J. Eide. Upon completion of her M. S. degree in 1946, she was awarded an assistantship at the University of Michigan to study under F. K. Sparrow, renowned aquatic mycologist. She resigned her assistantship to become Mrs. Curtis W. Roane in September 1947 and to move to Blacksburg, Virginia. There she worked for 14 months as a laboratory technician in the soil conservation section of the Agricultural Engineering Department at V.P.I.

Even as a technician, she published a paper on the recovery of platinum from potassium iodoplatinate.

From 1949 to 1956, Martha devoted herself exclusively to motherhood, but in 1956 she was offered employment as a part-time instructor in mathematics at V.P.I. In 1963, she was appointed Instructor in mathematics at Radford College for 1963-64 and Assistant Professor for 1964-68. Then fate evicted her from math and propelled her into botany. Radford College President Martin was prepared to promote her to Associate Professor and give her tenure when he discovered Martha had no degrees in math and by national accreditation standards was not qualified to teach college math. He had hired her upon the strength of recommendations from the V.P.I. Math Department and had not carefully examined her credentials. He duly assigned her to work as Assistant Director of Development for 1968-69 and allowed her leave time to renew her studies toward a Ph.D. in mycology at V.P.I. & S. U. There she was an advisee of R. A. Paterson who had been trained by Sparrow at Michigan. She was awarded her degree in 1971. She worked with O. K. Miller and Paterson as curator of fungal collections and taught biology laboratories during 1972-75. Fate again intervened when it was decided that three mycologists on the Biology Department faculty was one too many. Somehow, R. J. Stipes of the Department of Plant Pathology, Physiology and Weed Science, succeeded in having her appointed Adjunct Professor, and for several years she and Stipes contributed to the literature on the chestnut blight fungus and the genus *Endothia*. She was heavily involved as a cooperator with chestnut workers, especially Stipes and G. J. Griffin of V.P.I. & S.U., until a climax was reached with the publication of a monograph on chestnut blight. Meanwhile, an interest in the taxonomy of higher plants had been incubating and she published several papers on the Liliaceae, Poaceae and Ericaceae, especially *Rhododendron* species. She was co-editor with Bruce Parker of Volume IV, *Algae and Fungi* in the series *Distributional History of the Biota of the Southern Appalachians* and for several years was editor and a major contributor to *Jeffersonia*. With D. L. Coyier of Oregon State University, she organized and edited a *Compendium of Rhododendron Diseases* and with M. D. Cline of Monsanto Corp., St. Louis, she assembled a slide collection and prepared a text for *Diseases of Rhododendrons and Azaleas*; both of these were distributed by the American Phytopathological Society Press. Recently, she published in the *Virginia Journal of Science*, "The Grasses of Virginia," and with C. W. Roane, the "Fungal Diseases of Cereal Crops," and helped prepare manuscripts on fungi associated with Virginia grasses. If one were to examine a complete list of her publications, one would recognize that she would aptly be called a "botanist" having published in plant pathology, mycology, taxonomy of fungi and flowering plants, and having served as an editor of botanical publications. Martha did not limit her time to research and publications; she served on the Mycology Committee of APS, 1985-88, as a member of the Advisory Board of the Virginia Museum of Natural History, and on numerous committees of the Virginia Academy of Science. In the Botany Section of the Academy, she served as Vice-Chairman, Secretary, Chairman and Counselor. During eight years with the Flora Committee, she was Chairman, 1976-77, and Editor of *Jeffersonia* 1980-82. She served on several Academy committees: Local Arrangements, 1978-82; Chairman, Public Relations, 1978; Chairman Accommodations, 1982; Publications, 1982-84; Chairman Long Range Planning, 1983-86; Treasurer, 1982;

Secretary, 1982-83; Archives Committee, 1988-1996, Chairman, 1988-1992. She was honored to be nominated for President-elect in 1984. In 1991, she was named Fellow.

Martha did not limit her activities to science and professional societies. She served the community through the American Red Cross Bloodmobile Pack Table for over 15 years and was on the Montgomery County Board of the Red Cross more than five years; she was a Troop Leader and Board Member, and Secretary of the Virginia Skyline Girl Scout Council, 1974-76; she had received the Girl Scout Thanks Badge. In the Boy Scouts of America from 1977-1996, she held virtually every volunteer position imaginable, from Explorer Post Advisor (first woman in the district) to member of the Blue Ridge Mountains Council Executive Board (first woman), Wood Badge Staff Member (first woman) seven times, and member of the National Jamboree Staff, 1989. In 1991, she was tapped into the Order of the Arrow, and at the age of 70, like all initiates, she slept under the stars. The Council awarded her the Silver Beaver in 1986.

During the years she was Adjunct Professor at V.P.I. & S.U., she served for several years as Faculty Advisor and Chairman of the Advisory Committee of Alpha Phi Omega, a service Fraternity, and as Faculty Advisor to the V.P.I. & S.U. Student Services Council.

Martha had been honored by membership in Gamma Sigma Delta, Kappa Mu Epsilon, Pi Mu Epsilon, Sigma Xi, Phi Sigma, and Omicron Delta Kappa. One might look at the list of organizations and conclude she was just a joiner. Not so; when she joined, she took an active role in an organization and contributed ideas and guidance. She lived by the Boy Scout motto, laws, and oath.

Finally, you will note that she referred to herself as "c" of a committee. She disdained being called "chair", "chairperson" or "chairlady." She thought of the chairman as being either "Mr. Chairman" or "Madame Chairman", so to her chairman connoted being human as compared with "chairape," or "chairdonkey". "Madame Chairman" died December 31, 1996.

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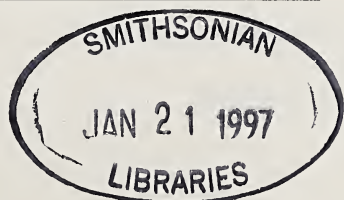
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CONSTITUTION OF VIRGINIA ACADEMY OF SCIENCE

ARTICLE I: NAME

The name of this organization shall be the Virginia Academy of Science.

ARTICLE II: PURPOSE

The purpose of this organization shall be to establish and maintain in Virginia for scientific and educational purposes an association of persons and organizations interested in science and scientific research in all of its branches; to solicit financial and other support; to cooperate with educational institutions, industries, and state agencies in fostering an interest in scientific matters, in promoting scientific investigations and in spreading knowledge of the sciences; to provide a forum for the presentation and discussion of papers on scientific subjects and facilities for their publication; to provide opportunities for the cooperation and fellowship among its members; and generally, in doing these things, to benefit not only its own members, but to promote the civic, agricultural, academic, industrial, and commercial welfare of the people of Virginia.

ARTICLE III: ORGANIZATION

Section 1. Membership

Membership in this organization shall be open to professional scientists of all branches of science and others who are interested in the purpose of the organization. Types of membership and dues for each shall be specified in Academy Bylaws. The membership, through the Academy Conference, provided by Section 2 of Article VIII, shall have ultimate authority over the affairs of this organization.

Section 2. Sections

The Academy shall be organized into Sections according to the various scientific disciplines. A person may belong to one or more Sections in accordance with his or her interests.

Section 3. Council

The governing body of this organization shall be the Academy Council. Its composition and responsibilities are specified in Article VII.

Section 4. Officers

The elected officers of this organization shall be a President, a President-Elect, a Vice President, a Secretary, and a Treasurer. Duties of each shall be specified in Academy Bylaws.

Section 5. Executive Committee

The elected officers, the immediate past president and the Director of the Junior Academy of Science shall comprise the Executive Committee of the Academy Council.

Section 6. Standing Committees

The primary activities of this organization shall be implemented by Standing Committees as follows: the Research Committee, the Long Range Planning Committee, the Junior Academy of Science Committee, the Membership Committee, the Finance and Endowment Committee, the Trust Committee, the Publications Committee, the Awards Committee, the Fund Raising Committee, the Nominations and Elections Committee, the Virginia Flora Committee, the Science Advisory Committee, the Science Education Committee, the Archives Committee, the Committee on the Environment, and the duties of the Standing Committees not specified hereafter, shall be as specified in the Academy Bylaws, and as may be further enumerated by Council from time to time.

ARTICLE IV: THE VIRGINIA JOURNAL OF SCIENCE

The Virginia Journal of Science shall be the official publication of the Virginia Academy of Science. All Academy members shall receive copies of this publication.

ARTICLE V: FELLOWS

From active membership, there shall be a body of scholars known as "Fellows of the Virginia Academy of Science" selected because of their contribution to science in one or more of the following ways: (a) outstanding scientific research, (b) inspirational teaching of science, (c) significant leadership in the Academy. Rules and procedures for selection of Fellows shall be specified in the Academy Bylaws.

ARTICLE VI: ACCREDITATION OF MEMBERSHIP

Membership of the Academy shall be accredited by the Secretary and the Treasurer. The membership list shall be published periodically according to types, as directed by Council.

ARTICLE VII: COMPOSITION AND RESPONSIBILITIES OF COUNCIL

Section 1. Council shall be composed of the President, the President-Elect, the Vice President, the Secretary, the Treasurer, the three most recent Past Presidents and one member elected by each Section of the Virginia Academy of Science. Members from the Sections shall be elected for three year terms on a rotational basis among the Sections, provided the initial term of a member from a newly established Section shall be specified by Council. In addition to the foregoing, the Chairs of the Standing Committees, the Editor of *The Virginia Journal of Science*, the Editor of *Virginia Scientists*, the official Academy Representative to the Board of Trustees of the Science Museum of Virginia, the official representative of the Academy to the American Association for Advancement of Science and National Association of Academies of Science, the Director of the Visiting Scientists Program, and the Director of the Virginia Junior Academy of Science shall be members of Council. In event of vacancies, the President shall make interim appointments until the next election is held; provided however, vacancies of elected officers shall be filled as hereafter provided.

Section 2. Council shall meet each year preceding the annual meeting and at least once in the fall at a time and place designated by the President.

Section 3. Twelve members shall constitute a quorum for the transaction of business by Council.

Section 4. Council shall establish the policies of this organization and shall be responsible for the administration of all Academy funds.

Section 5. Council shall consider and recommend to the membership from time to time appropriate changes in the Constitution, and shall promulgate bylaws appropriate to the implementation of the Constitution.

Section 6. Council may establish appropriate administrative positions and employ such personnel as may be required. Terms of office, the duties and remuneration of such personnel shall be prescribed by Council.

Section 7. Through appropriate Bylaws, Council shall provide for the publication of *The Virginia Journal of Science* and the *Virginia Scientists*.

Section 8. The Executive Committee of Council shall be empowered to act for Council on an interim basis between meetings of Council and shall report to Council at its regular meetings. A meeting of Council may be called at any time upon concurrence of any four members of the Executive Committee.

ARTICLE VIII: MEETINGS AND BUSINESS

Section 1. The annual meeting of this organization shall be arranged in accordance with procedures to be established by Council in appropriate Academy Bylaws.

Section 2. All business requiring action by the membership shall be transacted at an Academy Conference, which shall be scheduled by Council during the annual meeting. A meeting of the Academy Conference may be called between Annual Meetings by concurrence of a majority of the members of Council; provided, however, that the membership shall be notified of such called meeting no less than thirty (30) days prior to the date that such meeting is to be held. Forty accredited members shall constitute a quorum for the transaction of business by an Academy Conference.

Section 3. Each Section shall annually arrange a program oriented to its area of scientific interest; provided, however, such programs shall be compatible with the purpose of the Academy and scheduled within the framework of the general meeting program of the Academy.

Section 4. The fiscal year of the Academy shall be from January 1 through December 31.

Section 5. The parliamentary procedure for all meetings of this organization shall be governed by Robert's Rules of Order Revised, and Council shall provide for a Parliamentarian.

ARTICLE IX: ESTABLISHMENT OF SECTIONS

Section 1. Sections as defined in Article III with the approval of Council, may be organized by an accredited group of members. Each Section shall annually arrange a scientific program related to its area of interest.

Section 2. Such a Section may become accredited and established after it has conducted one successful program at an annual meeting of the Academy.

Section 3. Any Constitution and Bylaws changes proposed by a Section must conform to the provisions of the Academy Constitution and Bylaws and shall be submitted to Council for review and approval prior to adoption by Section.

Section 4. Any Section which fails to conduct a program at two successive Academy annual meetings, may be dropped as a Section by action of Council; but, may be reinstated after subsequently conducting one successful program.

Section 5. When established, all Section names shall be enumerated in the Academy Bylaws, and thereby subject to provisions of Article XIII, Section 1.

ARTICLE X: ELECTION OF ACADEMY AND SECTION OFFICERS

Section 1. A "Nominations and Elections Committee" consisting of three recent Past Presidents, appointed by the President, shall establish a slate of nominations for the positions of President-Elect, Vice President, Secretary, and Treasurer and conduct an election for same in accordance with procedures specified by Academy Bylaws.

Section 2. Upon election, officers shall serve one-year terms commencing at the annual meeting at which their election is announced and continuing until the next annual meeting; provided, however, the President-Elect shall automatically ascend to the position of President at the end of this scheduled term of office and at any prior time that the office of President may be vacated; however, such person shall not serve as President beyond the term that such person was originally scheduled to serve as President.

Section 3. All interim vacancies in Academy offices, other than President, occurring between annual Academy Conferences, shall be filled by Council from names of persons recommended by the Executive Committee. Persons so selected shall serve until the next Academy Conference.

Section 4. Each Section shall elect from their members:

- A. A Chair and a Secretary for one-year terms of office.
- B. A Representative to Council in accordance with the provisions of Article VII.
- C. Other officers desired.

Section 5. Persons to fill vacancies in Section offices which occur between Annual Meetings shall be designated by the Council Representative from that Section.

Section 6. All Elected officers shall serve without remuneration, but, at the discretion of Council, may be reimbursed for certain expenses incurred in conducting the business of the Academy.

ARTICLE XI: COMMITTEE STRUCTURE, APPOINTMENTS, TERMS, ETC.

Section 1. Except as provided otherwise, all Standing Committees shall be composed of three (3) or more members, and the President shall designate Committee Chairs, and appoint approximately one-third of the members of each Committee for terms of three (3) years, and shall subsequently appoint members to fill unexpired terms that occur periodically.

Section 2. The Research Committee shall be composed of five (5) members, each appointed for a term of five (5) years. One new member shall be appointed each year by the President to replace the member whose term expires; unexpired terms shall also be filled by appointment by the President. The senior member of the Committee shall be Chair.

Section 3. A Trust Committee, composed of three (3) accredited members, shall be elected by Council, to serve for terms of three (3) years on a rotational basis. The members of this Committee shall place in trust and supervise the management of Academy investments subject to annual review by Council. The Committee shall elect its own Chair; provided, however, that should it be unable to do so, the President shall name the Chair.

Section 4. The President and Council shall assign operational matters to appropriate Standing Committees; however, the President and/or Council may establish Special Committees as the need arises.

ARTICLE XII: JUNIOR ACADEMY OF SCIENCE

The Academy shall provide financial support, leadership, and supervision to a Junior Academy of Science. Effective working relationships shall be maintained with such Junior Academy of Science, through the Junior Academy of Science Committee.

ARTICLE XIII: BYLAWS AND AMENDMENTS

Section 1. Council shall promulgate appropriate Bylaws to implement or further clarify the Articles of this Constitution. The establishment or amendment of such Bylaws shall require an affirmative vote of a majority of the total membership of Council; provided, that all proposed Bylaws or amendments shall be distributed to the membership or published in an issue of *The Virginia Journal of Science* at least thirty (30) days prior to action by Council.

Section 2. This Constitution may be changed or amended, after the recommendation of a majority of the total membership of Council, by a two-thirds majority of an Academy Conference, provided all proposed changes shall be submitted to members of Council in writing no less than fifteen (15) days prior to the Council Meeting at which such proposals are to be considered and further provided that subsequent to approval by Council, all proposed amendments shall be published in *The Virginia Journal of Science* or distributed in writing to the membership no less than twenty five (25) days nor more than fifty (50) days prior to presentation to an Academy Conference for adoption.

Section 3. All provisions of the Constitution and Bylaws in effect prior to the adoption of this Constitution, except the provisions of this Article, shall rule until new Bylaws are duly established in accordance with Section 1 of this Article.

ARTICLE XIV: ARTICLES OF INCORPORATION

The Articles of Incorporation of this organization (Charter) shall conform to the provisions of this Constitution and all amendments hereafter adopted. The Constitution and Bylaws Committee shall review and coordinate all necessary appropriate revisions of both documents and be responsible for the submission of all required reports to the State Corporation Commission and other governmental entities, annually or as otherwise required by law.

ARTICLE XV: DISSOLUTION OR LIQUIDATION

Section 1. In the event of dissolution or liquidation, all liabilities and obligations of the Academy shall be paid, satisfied and discharged.

Section 2. All assets remaining, including those received and held for scientific and educational purposes, shall be transferred to one or more societies or organizations engaged in activities substantially similar to those of the Academy; provided however, that no assets shall accrue to the benefit of any officer or member of the Academy.

BYLAWS OF VIRGINIA ACADEMY OF SCIENCE

ARTICLE I: TYPES OF MEMBERSHIP AND DUES

Section 1. There shall be nine types of members: regular, student, contributing, sustaining, life, patron, honorary life, business, and emeritus.

Section 2. Dues of the first four types of members shall be as follows:

- A. Regular members shall pay annual dues of twenty-five dollars (\$25.00).
- B. Student members shall pay annual dues of ten dollars (\$10.00).
- C. Contributing members shall be individuals who elect to pay annual dues of thirty dollars (\$30.00).
- D. Sustaining members shall be individuals who elect to pay annual dues of fifty dollars (\$50.00) or more, and institutions which shall pay annual dues of one hundred dollars (\$100.00) or more.
- E. To be in good standing the foregoing types of members must pay the specified dues by July 1.

Section 3. Life members shall be individuals who elect to pay to the Academy the sum of five hundred dollars (\$500.00) and thereby become exempt from further payment of dues.

Section 4. Patrons shall be those persons who have given to this organization the sum of one thousand dollars (\$1,000.00) or its equivalent in property. They shall have all the rights and privileges of membership for one year. An institution may also become a Patron by meeting the above requirement. Its representative shall have all the rights and privileges of regular members.

Section 5. Honorary Life members shall be persons elected by the Council for long and distinguished service to science. They shall have all the rights and privileges of Regular Members and shall be exempt from dues. Previous active membership in this organization shall not be a requirement of eligibility.

Section 6. Business or industrial organizations, which elect to pay dues of one hundred dollars (\$100.00) annually, shall be Regular Business Members of the Academy, or may elect to:

- A. Pay annual dues of three hundred dollars (\$300.00) and be designated Contributing Business Members, or
- B. Pay annual dues of five hundred dollars (\$500.00) and be designated Sustaining Business Members.

Section 7. Emeritus Members shall be persons who have been active Academy members for at least ten years and retired from full-time employment. These Members shall have all rights and privileges of regular membership but will be exempt from dues. Eligibility for Emeritus membership status will be determined by requests to the Membership Committee.

ARTICLE II: DUTIES OF OFFICERS

Section 1. The President shall be the directing head of the Academy, shall preside at business meetings and general sessions of the organization, and shall appoint the members of the standing committees and of new committees authorized by the Council, in accordance with Article XI of the Constitution.

Section 2. The President-Elect shall assist the President as mutually agreed between them and shall serve as President in the latter's absence. The President-Elect shall furnish the Editor of *The Virginia Journal of Science*, in time for publication with the Summer issue of *The Virginia Journal of Science*, a list of committee memberships which he or she has set up to assist him or her during his or her year as President. The President-Elect shall distribute that list to Council at the Annual Meeting at which he or she automatically ascends to President. The President-Elect begins a three year term serving as a member of the Finance and Endowment Committee.

Section 3. The Vice President shall be responsible for coordinating the scientific programs of the Annual Meeting. The Vice President shall serve as a member of the Membership Committee.

Section 4. The Secretary shall be responsible for keeping complete records of the Academy Conference and all meetings of the Council and Executive Committee.

Section 5. The Treasurer shall:

- A. Account for the income and disbursements through one Academy General Fund Account.
- B. Keep the membership lists of the Academy up-to-date.
- C. Upon request, supply the Secretary and others a list of all members in good standing.
- D. Receive and disburse all funds as approved by Council and directed by the President or Chair of the Finance Committee and Endowment Committee.
- E. Submit to Council annually a written report of all receipts and disbursements, accompanied by a statement of audit from a certified public accountant.

- F. Furnish quarterly financial summaries to the Executive Committee, members of Council, and to members of the Finance Committee.
- G. Prepare annually and present to the Finance and Endowment Committee for review a proposed budget for Academy operations.

Section 6. The Treasurer and all administrative employees engaged in the receipt and disbursement of funds shall be adequately bonded.

Section 7. All officers shall be ex-officio members of all Academy Committees.

ARTICLE III: DUTIES OF STANDING COMMITTEES

Section 1. The Research Committee shall:

- A. Review and award Academy Research Grants.
- B. Arrange for and present the J. Shelton Horsley Research Award.

Section 2. The Long Range Planning Committee shall:

- A. Develop and advise Council on broad policies which will affect the Academy in the future.
- B. Solicit and study suggestions from the membership for the improvement of Academy activities.
- C. Investigate and evaluate proposed projects, publications and other factors that may relate to the long-range effectiveness of the Academy.
- D. Advise and consult with other Academy Committees relative to the foregoing and make recommendations to such committees concerning the effectiveness of their various activities.

Section 3. The Junior Academy of Science Committee of the Virginia Academy of Science shall:

- A. Assist the Executive Committee in selecting a Director and an Associate Director for the Virginia Junior Academy of Science.
- B. Coordinate with the Director activities of The Virginia Junior Academy of Science including development, expansion, and the annual meetings.
- C. Review funding proposals for the Virginia Junior Academy of Science and submit appropriate recommendations to the Executive Committee or other designated committees in a timely manner.
- D. Publish and distribute *Proceedings of Virginia Junior Academy of Science*.
- E. Select student representatives and alternates to attend The American Junior Academy of Science.
- F. Solicit membership and participation in Virginia Junior Academy of Science programs and projects.
- G. Support and participate in all other programs and activities related to the work of Virginia Junior Academy of Science.

- H. Set up procedures for selecting the top students and declare and announce them to be State Winners in the Virginia Science Talent Search, and all other contestants as runners-up.
- I. Carry out other duties that support the development of science in education as approved by Council.

Section 4. The Membership Committee shall:

- A. Make recommendations to Council, the Executive Committee and officers relative to policies on general membership.
- B. Promote membership growth and seek adequate representation from all scientific disciplines.
- C. Sponsor a Business Advisory Committee for the purpose of creating understanding between science and business, and to solicit business memberships to the Academy.

Section 5. The Finance and Endowment Committee shall:

- A. Monitor and appraise income and expenditures, and make appropriate recommendations to the President, Executive Committee and Council.
- B. Estimate annually the anticipated income of the Academy and prepare a proposed budget for consideration by Council at its Fall meeting.
- C. Seek and encourage the establishment of endowments to the benefit of Academy activities.
- D. Have at least one member of this Committee be a member of the Trust Committee.

Section 6. The Trust Committee shall:

- A. Place in trust and supervise the management of funds of the Academy designated by Council or otherwise for investment.
- B. Review all Academy investments annually and make appropriate adjustments subject to approval of Council.

Section 7. The Publications Committee shall:

- A. Develop and implement a continuing policy of review and evaluation of Academy publications.
- B. Present to Council annually through the Finance Committee the budgetary needs of the several Academy periodical publications.
- C. Make recommendations to Council relative to priority, publication, finance and distribution of non-recurring publications.
- D. Select and recommend to Council, as necessary; an Editor for the *Virginia Journal of Science*, and members of the editorial Board.
- E. Enlist the interest of all groups in worthwhile publications by the Academy.

Section 8. The Awards Committee shall:

- A. Select recipients of the Ivey F. Lewis Distinguished Service Award to be presented periodically to a member who has made significant contributions toward the activities of the Virginia Academy of Science.
- B. Select recipients of Special Awards periodically as directed by Council.
- C. Accept and submit to Council nominations for fellows in accordance to Article V of the Constitution and Article V of the Bylaws.

Section 9. The Fund Raising Committee shall:

- A. From time to time at the direction of Council, plan, organize, and coordinate appropriate fund raising campaigns in support of Academy activities or projects contingent to the purposes of the Academy.

Section 10. The Nominations and Elections Committee shall:

- A. Mail to the membership on or about January 1 each year a request for nominations of persons to fill the offices of President-Elect, Vice President, Secretary and Treasurer.
- B. Nominate a slate of one person for each of the aforementioned offices and present report to Council for informational purposes.
- C. Mail slate of nominees to members advising that names may be added to the slate by 25 members petitioning the committee on behalf of each name to be added.
- D. Prepare ballots with or without additional nominees as the case may be and mail to membership with registration and other information relative to annual meeting indicating deadline and address for return of ballot to committee.
- E. Count ballots and announce results at the Academy Conference. Should a tie vote result for any office, the Academy Conference shall vote on the nominees. In all cases, the nominee receiving the largest number of favorable votes shall be elected; provided, however, that only members in good standing may cast ballots.

Section 11. The Constitution and Bylaws Committee shall:

- A. Periodically receive and prepare drafts of all proposed changes in constitution as the occasion arises and present same to Council and membership for consideration as set forth in the constitution.
- B. Draft all Bylaw changes as directed by Council and notify membership of such changes.
- C. Update articles of Incorporation (Charter) as required.
- D. Provide a Parliamentarian for all Council meetings and Academy Conferences.

Section 12. The Virginia Flora Committee shall:

- A. Promote the study of and publications of the flora and vegetation of Virginia.
- B. Sponsor symposia and conferences on the ecology, conservation, and preservation of the plant life of Virginia.
- C. Disseminate botanical information to all who are interested in the flora and ecology of Virginia.
- D. Serve as liaison between the Academy, government bodies, and institutions in matters pertaining to the plant life of Virginia.

Section 13. The Science Advisory Committee Shall:

- A. Provide scientific and technical information and advice requested by the Executive, Legislative, and other governmental bodies and agencies of the Commonwealth of Virginia.
- B. Serve as liaison for the collection and transfer of scientific information and/or advice solicited in (A).
- C. Collect and evaluate suggestions and opinions regarding topics of general public interest wherein science and technology may provide assistance, but where such assistance has not been requested. The Science Advisory Committee will make recommendations to the Academy, to the Executive Committee, and/or the Council of the Academy for review and approval. The Science Advisory Committee, upon direction of Council or Executive Committee, shall serve as a conduit for placement of such information before the appropriate Executive, Legislative, or other governmental body or agency.
- D. Maintain an inventory of scientific interests and expertise of individuals within the Academy who are willing to serve in an advisory and/or consultant capacity to state government.
- E. At no time operate beyond constraints considered as proper conduct for a non-profit organization.
- F. Append all reports and recommendations with a statement as follows; "The Virginia Academy of Science assumes no legal or financial responsibility for the utilization or dispersal of scientific and technical data or advice provided by the science Advisory Committee, further, the Academy assumes no responsibility, financial or other-wise, to governmental agents or agencies, institutions, individuals or committee members pursuant to the conduct and activities of this Committee."

Section 14. The Science Education Committee shall:

- A. Promote science education in the State of Virginia.
- B. Disseminate information about scientific matters and scientific topics of current interest.
- C. Respond to requests for assistance in matters dealing with education in the areas of mathematics and science, such as are embraced by the

various Academy Sections and as directed by the President and Council of the Academy.

- D. Assist and cooperate with the Virginia State Department of Education in planning and conducting the annual State Science Teachers Conference, K-12. Delegated members of the Committee may hold and be responsible for funds generated by the activities of the State Science Teachers Conference, solely for the purpose of funding the Conference meetings. These funds shall remain separate from other funds of the Academy.

Section 15. The Archives Committee shall:

- A. Address the business of collection, assembly, organization, cataloguing and storage of records, documents, awards and paraphernalia associated with the history and development of the Academy.
- B. Secure an institutional repository for storage of the inactive records of the Academy.
- C. Secure the services of a qualified individual to establish and maintain the aforementioned records, as the official Archivist of the Academy; and such person shall be extended honorary membership in the Academy.
- D. Assist, and cooperate, with the Archivist in securing and screening of records and documents destined for permanent storage in the Archives.

Section 16. The Committee on the Environment shall:

- A. Maintain close liaison with organizations and agencies involved in environmental study and management.
- B. Keep informed of the status of Virginia's environment, noting particularly those problems and issues amenable to scientific research.
- C. Cooperate with the Science Advisory Committee in advising and providing information to private and public environmental agencies and bodies.

ARTICLE IV: THE VIRGINIA JOURNAL OF SCIENCE

Section 1. The Academy shall publish *The Virginia Journal of Science* quarterly.

Section 2. The staff of *The Virginia Journal of Science* shall be composed of:

- A. An editor recommended by the Publications Committee and appointed by Council for a three-year term.
- B. Such Associate Editors, Assistant Editors, or Editorial Board Members, appointed by the President, as are recommended by the Editor and the Publications Committee.
- C. Editors designated by individual Sections.

Section 3. All members of the Academy shall receive *The Virginia Journal of Science*.

Section 4. Subscriptions may be sold to non-members at a rate established by the Publications Committee and approved by Council.

ARTICLE V: RULES AND PROCEDURES FOR SELECTING FELLOWS

Section 1. A Fellow must be nominated by at least three members of the Academy. The Academy Council must approve each Fellow by a majority vote. It will be the usual procedure to announce new Fellows at an Annual Meeting.

Section 2. Nominations for Fellows with appropriate biographical information shall be sent directly to the Executive Secretary-Treasurer annually prior to October 1. All information received shall be forwarded to the Chair of the Awards Committee for review and recommendations to Council prior to the subsequent Annual Meeting. All nominees not recommended by the Committee or not acted upon favorably by Council shall remain in consideration for one additional year.

Section 3. No more than twenty-five fellowships will be approved the first year. After the first year, no more than one-half of one percent of the total active membership shall be selected in any one year. The limiting number of Fellows shall not exceed five percent of the total active membership of the Academy. However, nothing in this section shall preclude the election of one Fellow each year.

Section 4. All Fellows shall be presented with a suitably inscribed scroll.

Section 5. Appropriate announcement of new Fellows shall be made in *The Virginia Journal of Science*.

ARTICLE VI: THE DULY ORGANIZED SECTIONS OF THE ACADEMY

The duly organized scientific sections of the Academy are:

- (1) Agriculture, Forestry, and Aquaculture
- (2) Astronomy, Mathematics, and Physics
- (3) Microbiology and Molecular Biology
- (4) Biology
- (5) Chemistry
- (6) Materials Science
- (7) Biomedical and General Engineering
- (8) Geology
- (9) Medical Sciences
- (10) Psychology
- (11) Education
- (12) Statistics
- (13) Aeronautical and Aerospace Sciences
- (14) Botany
- (15) Environmental Science
- (16) Archaeology
- (17) Computer Science
- (18) Geography
- (19) Natural History and Biodiversity

ARTICLE VII: OFFICIAL REPRESENTATION OF THE ACADEMY

Section 1. Where official representation of the Academy is desirable, the President, the President's designees, or an official representative appointed by Council shall represent The Academy.

Section 2. No Officer or Academy Member shall receive reimbursement from Academy funds for such purposes except as included in the annual budget of the Academy or separately approved by Council from available funds.

Section 3. The official representative to serve as delegate to the American Association for the Advancement of Science (AAAS) shall be appointed by Council for a term designated by the AAAS. Actual expenses of the official representative in attending the Annual Meeting of AAAS may be paid if the funds are included in the budget or separately approved by Council.

Section 4. The official representative to serve on the Board of Trustees of the Science Museum of Virginia shall be recommended by Council and serve as an ex officio member of Council. Actual expenses of the official representative may be paid if the funds are included in the budget or separately approved by Council. Expenses payable by the Board or Science Museum of Virginia shall not be reimbursed by the Academy.

ARTICLE VIII: MEETINGS AND BUSINESS

The annual meeting of this organization shall be held in the Spring of each year at a time and place selected by Council, which shall arrange for all appropriate sessions.

ARTICLE IX: EXECUTIVE SECRETARY-TREASURER

Section 1. The position of Executive Secretary-Treasurer is hereby established for the purpose of providing administrative assistance to the officers and committee chairs.

Section 2. The Executive Committee shall select a qualified person for this position, specify his or her duties, and set appropriate remuneration which shall be approved by Council.

Section 3. The incumbent of this position shall serve at the pleasure of the Executive Committee, subject to review by Council.

Section 4. The incumbent of this position shall attend all Council and Executive Committee Meetings and may participate in all deliberations as circumstances dictate, but, shall not have a vote in either body.

ARTICLE X: VISITING SCIENTISTS PROGRAM DIRECTOR

Section 1. The position of Visiting Scientists Program Director is hereby established for the purpose of implementing a Visiting Scientists Program in cooperation with the State Board of Education.

Section 2. The Executive Committee upon recommendation of the President shall select a qualified person for this position and approve guidelines for the conduct of the program.

Section 3. The incumbent of this position shall serve at the pleasure of the Executive Committee, subject to review by Council.

ARTICLE XI: THE DIRECTOR OF THE VIRGINIA JUNIOR ACADEMY
OF SCIENCE

Section 1. The position of Director of the Virginia Junior Academy of Science is hereby established for the purpose of providing leadership, supervision, and administrative support to the Virginia Junior Academy of Science and the Junior Academy of Science Committee.

Section 2. The Executive Committee, subject to the approval of Council, shall select a qualified volunteer for this position.

Section 3. The incumbent of this position shall serve at the pleasure of the Executive Committee subject to review by Council.

Section 4. Duties of the Director of the Virginia Junior Academy of Science.

- A. The Virginia Junior Academy of Science Director shall provide leadership, supervision and administrative support to the Virginia Junior Academy of Science.
- B. The Virginia Junior Academy of Science Director shall be a member of The Virginia Academy of Science, shall attend all Council and Executive Committee meetings and may participate in all deliberations.
- C. The Virginia Junior Academy of Science Director shall prepare an annual budget for the Virginia Junior Academy of Science and submit the Virginia Junior Academy of Science budget with Virginia Junior Academy of Science Committee recommendations to the Academy Finance and Endowment Committee by September 1.
- D. The Virginia Junior Academy of Science Director shall coordinate all fund raising by the Virginia Junior Academy of Science with the Fund Raising Committee, The Trust Committee, and The Finance and Endowment Committee.
- E. The Virginia Junior Academy of Science Director shall be responsible for the program of Virginia Junior Academy of Science at the annual meeting of the Academy and coordinate Virginia Junior Academy of Science activities with the Virginia Academy of Science Program Chair.
- F. The Virginia Junior Academy of Science Director shall be responsible for the development and expansion of the Virginia Junior Academy of Science as approved by Council.
- G. The Virginia Junior Academy of Science Director shall serve as Chair the Junior Academy of Science Committee with the approval of the President.
- H. The Virginia Junior Academy of Science Director shall carry out other duties specified by the Virginia Junior Academy of Science Committee or the Executive Committee as approved by Council.

ARTICLE XII: ASSOCIATE DIRECTOR OF THE VIRGINIA JUNIOR ACADEMY OF SCIENCE

Section 1. The position of Associate Director of the Virginia Junior Academy of Science is hereby established for the purpose of providing administrative assistance to the Junior Academy of Science Committee, the Chair of the Junior Academy of Science Committee and the Director of the Virginia Junior Academy of Science.

Section 2. The Executive Committee, subject to the approval of Council, shall select a qualified person for the position, specify his or her duties, and set appropriate remuneration, if any.

Section 3. The incumbent of this position shall serve at the pleasure of the Executive Committee, subject to annual review by Council and by the Junior Academy of Science Committee.

Section 4. The incumbent of this position shall be a member of the Virginia Academy of Science, attend all Council meetings and all Virginia Junior Academy of Science Committee meetings, and may participate in all deliberations as circumstances dictate, but shall not have a vote in either body.

ARTICLE XIII: VIRGINIA SCIENTISTS NEWSLETTER

Section 1. The Virginia Academy of Science shall publish periodically the *Virginia Scientists* as its newsletter.

Section 2. The staff of the *Virginia Scientists* shall be composed of:

- A. An Editor recommended by the Publications Committee and appointed by Council for a three-year term.
- B. Such Associate Editors, Assistant Editors, or Editorial board Members, appointed by the President, as are recommended by the Editor.

Section 3. The Editor shall serve on the Publications Committee and on Council.

Section 4. All members of the Virginia Academy of Science shall receive the *Virginia Scientists*.

ARTICLE XIV: OFFICIAL ABBREVIATIONS

Section 1. The official abbreviation for the Virginia Academy of Science shall be **VAS**.

Section 2. The official abbreviation for the Virginia Junior Academy of Science shall be **VJAS**.

**FUTURE MEETINGS
AND
CHAIRS OF LOCAL ARRANGEMENTS COMMITTEES**

(For list of Committee Members in charge of scheduling, registration, exhibits, etc.; see **Special Committee on Local Arrangements** listings.)

75th Anniversary of The Virginia Academy of Science

56th VJAS...May 20-23, 1997

Virginia Polytechnic Institute and State University

Blacksburg, Virginia

John L. Hess, Department of Biochemistry, Virginia Tech,
Blacksburg, VA 24061-0308
540-231-5336
JLHESS@VT.EDU

FAX: 540-231-9070

Tom O. Sitz, Department of Biochemistry, Virginia Tech,
Blacksburg, VA 24061-0308
540-231-4970
TOSITZ@VT.EDU

FAX: 540-231-9070

76th VAS...57th VJAS...May 1998

George Mason University, Fairfax, Virginia

George W. Mushrush, Department of Chemistry,
George Mason University, 4000 University Drive,
Fairfax, Virginia 22030
703-993-1080 or 1070 (O)

FAX: 703-993-3193

77th VAS...58th VJAS...May 1999

Old Dominion University, Norfolk, Virginia

78th VAS...59th VJAS...May 2000

Radford University, Radford, Virginia

(NOTE: Academy Central Office, Publications, and other frequently used addresses and phones are listed on the inside back cover.)

EXECUTIVE COMMITTEE**President**

R. Dean Decker, Department of Biology
 University of Richmond, Richmond, VA 23173
 804-289-8231 (O) 804-282-1631 (H) FAX: 804-289-8233
 DECKER@URVAX.URICH.EDU

President-Elect

Harold G. Marshall, Dept. of Biological Sciences
 Old Dominion University, Norfolk, VA 23529-0266
 757-683-4204 (3595), FAX: 757-683-5283
 HGM100F@VIPER.MGB.ODU.EDU

Vice President

Carolyn M. Conway, Box 842012,
 Virginia Commonwealth University, Richmond, VA 23284
 804-828-1562 (O) FAX: 804-828-0503
 CCONWAY@SATURN.VCU.EDU

Secretary

Judy H. Niehaus, Box 6931, Dept. of Biology,
 Radford University, Radford, VA 24142
 540-831-5146 (O) 540-951-3556 (H) FAX: 540-831-6615
 JNIEHAUS@RUNET.EDU

Treasurer

D'Arcy Mays, Department of Mathematical Sciences, P. O. Box 842014, VCU,
 Richmond, VA 23284-2014
 804-828-1301 FAX: 804-828-8785
 DMAYS@ATLAS.VCU.EDU

Immediate Past President

Tom Sitz, Department of Biochemistry
 Virginia Tech, Blacksburg, VA 24061-0308
 540-231-4970 (O) 540-231-6315 (Main Office)
 540-951-7332 (H) FAX: 540-231-9070
 TOSITZ@VT.EDU

Director, Virginia Junior Academy of Science

Donald R. Cottingham
 910 Greenway Court # 1, Norfolk, VA 23507
 757-622-6239 (H) FAX: 757-622-4412

Executive Secretary-Treasurer (Non-Voting)

Arthur W. Burke, Jr., Virginia Academy of Science,
 Science Museum of Virginia, 2500 W. Broad St., Richmond, VA 23220
 804-367-8971 (O) 804-746-3283 (H) FAX: 804-371-3311

1995-96 ACADEMY COUNCIL

ELECTED OFFICERS

President

R. Dean Decker, Department of Biology
University of Richmond, Richmond, VA 23173
804-289-8231 (O) 804-282-1631 (H) FAX: 804-289-8233
DECKER@URVAX.URICH.EDU

President-Elect

Harold G. Marshall, Dept. of Biological Sciences
Old Dominion University, Norfolk, VA 23529-0266
757-683-4204 (3595), FAX: 757-683-5283
HGM100F@VIPER.MGB.ODU.EDU

Vice President

Carolyn M. Conway, Box 842012,
Virginia Commonwealth University, Richmond, VA 23284
804-828-1562 (O) FAX: 804-828-0503
CCONWAY@SATURN.VCU.EDU

Secretary

Judy H. Niehaus, Box 6931, Dept. of Biology,
Radford University, Radford, VA 24142
540-831-5146 (O) 540-951-3556 (H) FAX: 540-831-6615
JNIEHAUS@RUNET.EDU

Treasurer

D'Arcy Mays, Department of Mathematical Sciences, P. O. Box 842014, VCU,
Richmond, VA 23284-2014
804-828-1301 FAX: 804-828-8785
DMAYS@ATLAS.VCU.EDU

Executive Secretary-Treasurer (Non-Voting)

Arthur W. Burke, Jr. Virginia Academy of Science,
Science Museum of Virginia, 2500 W. Broad St., Richmond, VA 23220
804-367-8971 (O) 804-746-3283 (H) FAX: 804-371-3311

Director, Virginia Junior Academy of Science

Donald R. Cottingham
910 Greenway Court # 1, Norfolk, VA 23507
757-622-6239 (H) FAX: 757-622-4412
DRC@jericho.com

Immediate Past Presidents (3)

1995-96: Tom Sitz, Department of Biochemistry
 Virginia Tech, Blacksburg, VA 24061-0308
 540-231-4970 (O) 540-231-6315 (Main Office)
 540-951-7332 (H) FAX: 540-231-9070
 TOSITZ@VT.EDU

1994-95: Elsa Q. Falls, Department of Biology
 Randolph-Macon College, Ashland, VA 23005
 804-752-7203 (O) 804-740-1492 (H) FAX: 804-752-7231
 EFALLS@RMC.EDU

1993-94: James P. O'Brien, Psychology-VBC, Tidewater Community College,
 1700 College Crescent, Virginia Beach, VA 23456
 757-427-7171 (O) or 7207 (Secy) FAX: 757-427-7326
 757-423-4113 (H)

Editor, The Virginia Journal of Science

(1996) James H. Martin, Department of Biology-PRC,
 J. Sargeant Reynolds Community College, Box 85622,
 Richmond, VA 23285-5622
 804-371-3064 (O) 804-262-0517 (H) FAX: 504-371-3311
 SRMARTJ@jsr.cc.va.us

Director, Visiting Scientists Program

(1996) Jack Cranford, 2113 B Derring Hall, Department of Biology
 Virginia Tech, Blacksburg, VA 24061
 540-231-5371 (O)
 CRANFORD@VT.EDU

AAAS/NAAS Representative

(1997) Ertle Thompson, Ruffner Hall
 University of Virginia, Charlottesville, VA 22903
 804-924-0840 (O) 804-293-7330 (H)

Science Museum of Virginia Trustee

D. Rae Carpenter, Jr., (1999)
 Department of Physics & Astronomy
 Virginia Military Institute, Lexington, VA 24450
 540-464-7225 (O) 540-463-4948 (H)

Editor, Virginia Scientists

William Cunningham (1999)
 Psychology - VBC, Tidewater Community College
 1700 College Crescent, Virginia Beach, VA 23456
 757-427-7207 (Secy) FAX: 757-427-7326

Gwathmey and Jeffress Trusts Allocation Committee Representative (Non-Voting)

(1997) Elsa Q. Falls, Department of Biology
Randolph-Macon College, Ashland, VA 23005

804-752-7203 (O) 804-740-1492 (H)

FAX: 804-752-7231

EFALLS@RMC.EDU

SECTION REPRESENTATIVES TO COUNCIL

Aeronautical and Aerospace Sciences Section

(1997) Fred H. Lutze, Jr., Department of Aerospace and Ocean Engineering
Virginia Tech, Blacksburg, VA 24061

540-231-6409

Agriculture, Forestry, and Aquaculture Section

(1999) Scott H. Newton, VA State University, P.O. Box 8091, Petersburg,
VA 23806

804-524-5495

FAX: 804-524-5245

Archaeology Section

(1998) Eugene B. Barfield, 5162 Valleypoint Parkway, George Washington
& Jefferson National Forests, Roanoke, VA 24019

540-265-6058

FAX: 540-265-6012

Astronomy, Mathematics, and Physics Section

(1998) Gerald R. Taylor, Jr., Physics Department, James Madison University,
Harrisonburg, VA 22807

540-568-6328

FAX: 540-568-7938

FAC_TAYL@JMU.VAX1

Biology Section

(1996) Carolyn M. Conway, Department of Biology, Box 842012,
Virginia Commonwealth University, Richmond, VA 23284-2012

804-828-1562

FAX: 804-828-0503

CCONWAY@SATURN.VCU.EDU

Biomedical and General Engineering (1 vote, 2 Co-Representatives)

(1996) John B. Crittenden, Engineering Fundamentals Division, VPI&SU,
Blacksburg, VA 24061-0218

540-231-6555

FAX: 540-231-6903

BCRITTEN@VTVM1.CC.VT.EDU

Botany Section

(1998) Marion Blois Lobstein, NVCC-Manassas Campus,
 6901 Sudley Road, Manassas, VA 22110
 43 (O) NVCC-Manassas Campus) 703-536-7150 (H)
 MBLOBST@MNSINC.COM

Chemistry Section

(1997) George W. Mushrush, Department of Chemistry,
 George Mason University, Fairfax, VA 22030
 703-993-1080 FAX: 703-993-3193

Computer Science Section

(1996) Robert A. Willis, Jr., Department of Computer Science,
 Hampton University, Hampton, VA 23668
 757-727-5835 FAX: 757-727-5390
 WILLIS@WILLIS.CS.HAMPTONU.EDU

Education Section

(1998) Pamela C. Turpin, Department of Chemistry, Roanoke College,
 221 College Lane, Salem, VA 24153-3794
 540-375-2439 (O) 540-586-8067 (H)
 PTURPIN@ACC.ROANOKE.EDU

Environmental Science Section

(1997) Michael L. Bass, Department of Environmental Science and Geology,
 Mary Washington College, Fredericksburg, VA 22401
 540-654-1424 FAX: 540-654-1018

Geography Section

(1996) Stephen E. Wright, Department of Geology and Geography,
 James Madison University, Harrisonburg, VA 22807
 540-568-6130 FAX: 540-568-6920
 IN%FACSWRIGHT@JMU.EDU

Geology Section

(1998) Bruce K. Goodwin, Dept. of Geology, College of William & Mary, Wil-
 liamsburg, VA 23187-8795
 757-221-2443 FAX: 757-221-2093
 BKGOOD@MAIL.WM.EDU

Materials Science Section

(1997) Kenneth R. Lawless, Department of Materials Science
 Thornton Hall, University of Virginia, Charlottesville, VA 22903
 804-924-3462
 KRL@VIRGINIA.EDU

Medical Sciences Section

(1999) Amelia Compton, Dept. of Psychology, University of Richmond, Richmond, VA 23173

804-289-8123

FAX: 804-289-8943

COMPTON@URVAX.URICH.EDU

Microbiology and Molecular Biology Section

(1998) Judy H. Niehaus, Box 6931, Radford University, Radford, VA 24142

540-831-5146 (O)

540-951-3556 (H)

FAX: 540-831-6615

JNIEHAUS@RUNET.EDU

Natural History and Biodiversity Section

(1998) Michael Kosztarab, Department of Entomology, VPI&SU,

Blacksburg, VA 24061-0319

540-231-6773 (O)

Psychology Section

(1999) Robert A. Berquest, Psychology-CC, Tidewater Community

College, 1428 Ceder Road, Chesapeake, VA 23320

757-490-8058 (O)

757-527-7329 (H)

FAX: 757-549-5173

Statistics Section

(1997) Don Jensen, VPI&SU

(DEPT.)

FAX:

CHAIRS OF STANDING COMMITTEES**Archives Committee**

Golde I. Holtzman, Department of Statistics, (1999)

VPI & SU, Blacksburg, VA 24061-0439

540-231-8356 (O)

540-951-7259 (H)

FAX: 540-231-3863

HOLTZMAN@VTVM1.CC.VT.EDU

Awards Committee

Robert E. Johnson, Department of Mathematical Sciences, (1998)

Virginia Commonwealth University, Richmond, VA 23284-2014

804-367-1301 (O)

FAX: 804-367-8785

RJOHNSON@RUBY.VCU.EDU

Committee on the Environment

Michael L. Bass, Department of Environmental Sciences and Geology, (1998)

Mary Washington College, Fredericksburg, VA 22401

540-899-4358 (O)

540-972-2453 (H)

FAX: 540-899-4766

Constitution and Bylaws Committee (Co-Chairs) (1998)

Michael L. Bass, Department of Environmental Sciences and Geology

Mary Washington College, Fredericksburg, VA 22401

540-899-4358 (O)

540-972-2453 (H)

FAX: 540-899-4766

Gerald R. Taylor, Jr., Physics Department, (1998)

James Madison University, Harrisonburg, VA 22807

540-568-6109 or

568-6328 (O)

540-433-1251 (H)

FAC_TAYL@JMU VAX1

Finance and Endowment Committee

Paul J. Homsher, Director of Development, (1999)

Dean's Office, College of Sciences,

Old Dominion University, Norfolk, VA 23529

757-683-3319 (O)

757-497-6833 (H)

HOMSHER@CS.ODU.EDU

Fund Raising Committee (Co-Chairs)

James P. O'Brien, Psychology-VBC, Tidewater Community College, (1997)

1700 College Crescent, Virginia Beach, VA 23456

757-427-7171 (O) or

427-7207 (Secy)

757-423-4113 (H)

FAX: 757-427-7326

Richard B. Brandt, Department of Biochemistry (1999)

MCV/VCU, Box 980614, Richmond, VA 23298-0614

804-828-0104 (O), 804-355-0436 (H), FAX: 804-786- 1473

BRANDT@VCU VAX

Junior Academy of Science Committee

Donald R. Cottingham, 910 Greenway Court # 1, Norfolk, VA 23507

757-622-6239 (H)

FAX: 757-622-4412

Long Range Planning Committee (Co-Chairs)

Richard B. Brandt, Department of Biochemistry, MCV/VCU (1998)

Box 980614, Richmond, VA 23298

804-828-0104 (O)

804-355-0436 (H)

FAX: 804-828-1473

BRANDT@VCU VAX

1995-96: Tom Sitz, Department of Biochemistry (1999)

Virginia Tech, Blacksburg, VA 24061-0308

540-231-4970 (O)

540-231-6315 (Main Office)

540-951-7332 (H)

FAX: 540-231-9070

TOSITZ@VT.EDU

Membership Committee (Co-Chairs)

Scott H. Newton, Virginia Department of Agriculture and Consumer Services
(1998)

(VDACS), Box 1163, Richmond, VA 23209

804-786-4435 (O)

FAX: 804-371-7786

Joseph W. Rudmin, Department of Physics (1999)

James Madison University, Harrisonburg, VA 23703

540-568-6548 (O)

RUDMINJW@VAX1.ACS.JMU.EDU

Nominations and Elections Committee

James P. O'Brien, Psychology-VBC, Tidewater Community College, (1997)

1700 College Crescent, Virginia Beach, VA 23456

757-427-7171 (O) or

427-7207 (Secy)

757-423-4113 (H)

FAX: 757-427-7326

Publications Committee (Co-Chairs)

James H. Martin, Department of Biology-PRC, (1999)

J. Sargeant Reynolds Community College, Box 85622,

Richmond, VA 23285-5622

804-371-3064 (O)

804-262-0517 (H)

FAX: 804-371-3311

SRMARTJ@JSR.CC.VA.US

William Cunningham (1999)

Psychology - VBC, Tidewater Community College

1700 College Crescent, Virginia Beach, VA 23456

757-427-7207 (Secy)

FAX: 757-427-7326

Research Committee

Arthur F. Conway, Department of Biology (1999)

Randolph-Macon College, P. O. Box 5005, Ashland, VA 23005-5505

804-752-3720 (O).

FAX: 804-752-7345 or
7231

ACONWAY@RMC.EDU

Science Advisory Committee

William L. Dewey, Research and Graduate Affairs, MCV/VCU,

Box 568, Richmond, VA 23298

804-828-0732 (O)

FAX: 804-786-1664

Science Education Committee (Co-Chairs)

Thomas G. Teates, 305 Memorial Hall, VPI & SU,

Blacksburg, VA 24061-0313

540-231-5537 (O)

540-382-0542 (H)

FAX: 540-231-9075

TEATES@VTVM1

Maurice P. Lynch, Virginia Institute of Marine Science,
Gloucester Point, VA 23062

804-642-7151 (O)

FAX: 804-642-6120

MLYNCH@VIMS.EDUM.LYNCH.VIMS

Trust Committee

D. Rae Carpenter, Jr., Department of Physics and Astronomy, (1999)

Virginia Military Institute, Lexington, VA 24450

540-464-7225 (O)

540-463-4948 (H)

Virginia Flora Committee

J. Rex Baird, Department of Biology, (1998)

Clinch Valley College, Wise, VA 24293

540-328-0201 (O)

540-328-6540 (H)

JRB@CLINCH.EDU

CHAIRS OF SPECIAL COMMITTEES (Non-Voting)

Public Affairs Committee

Ralph P. Eckerlin, Natural Sciences Division,

Northern Virginia Community College, Annandale, VA 22003

703-323-3234 (O)

FAX: 703-323-3215

75th Anniversary Committee

Golde I. Holtzman, Department of Statistics, (1997)

VPI & SU, Blacksburg, VA 24061-0439

540-231-8356 (O)

FAX: 540-231-3863

HOLTZMAN@VT.EDU

1996/VCU Local Arrangements Committee

Thomas W. Haas, Director, Cooperative Graduate Engineering Program

Virginia Commonwealth University, Richmond, VA 23284-2009

804-828-0266,

FAX: 804-367-9164

THAAS@CABELL.VCU.EDU

SECTIONS AND SECTION OFFICERS

AERONAUTICAL AND AEROSPACE SCIENCES

Chair: Henri Fuhrmann, NASA Langley Research Center, MS 248

Hampton, VA 23666

804-864-5254

FAX: 804-864-3553

H.D.FUHRMANN@LARC.NASA.GOV

Secretary: Jeanette Elliott, NASA Langley Research Center, MS 248 Hampton,
VA 23666

757-864-5990

FAX: 757-864-3553

JEANEH@LARC.NASA.GOV

Council Representative: Fred H. Lutz, Jr.

(1997)

Department of Aerospace and Ocean Engineering, VPI&SU,

Blacksburg, VA 24061

540-231-6409

Vice Chair: Leroy Spearman, NASA Langley Research Center, MS 248

Hampton, VA 23666

804-864-5226

FAX: 804-864-3553

M.L.SPEARMAN@LARC.NASA.GOV

AGRICULTURE, FORESTRY, AND AQUACULTURE

Chair: Ali Mohamed, VA State University, P.O. Box 9259, Petersburg, VA
23806

804-524-6715

FAX: 804-524-5186

NUTAGBIO@AOL.COM or AMOHAMED@VSU.EDU

Secretary:

Council Representative: Scott H. Newton

(1999)

VA State University, P.O. Box 8091, Petersburg, VA 23806

804-524-5493

FAX: 804-524-5245

Editor: Scott H. Newton, VA State University, P.O. Box 8091, Petersburg, VA
23806

804-524-5493

FAX: 804-524-5245

ARCHAEOLOGY

Chair: Donald W. Linebaugh, Dept. of Anthropology, William & Mary, P.O.
Box 8795, Williamsburg, VA 23187-8795

757-221-2579

FAX: 757-221-2564

DWLINE@FACSTAFF.WM.EDU

Secretary: Michael B. Barber, 5162 Valley Point Parkway, Roanoke, VA 24019
540-265-5221 540-265-5145

Council Representative: Eugene B. Barfield (1998)
379 Walnut Ave., SW, Roanoke, VA 24016
540-345-9706 FAX: 540-345-9706
800-757-3879 PIN 3493
Editor: Andrew Veech, 3819 Javins Dr., Alexandria, VA 22310
703-950-2941

ASTRONOMY, MATHEMATICS, AND PHYSICS

Chair: Jane Carter Webb, Dept. of Physics and Computer Science, Christopher Newport University, Newport News, VA 23606
804-594-7082 FAX: 804-594-7919
JWEBB@PCS.CNU.EDU

Secretary: Brian Bradie, Mathematics Department, Christopher Newport University, Newport News, VA 23606
804-594-7944 FAX: 804-594-7919
BBRADIE@PSC.CNU.EDU

Council Representative: Gerald R. Taylor, Jr. (1998)
Physics Department, James Madison University, Harrisonburg, VA 22807
540-568-6328 FAX: 540-568-2800
TAYLORGR@JMU.VAX1

Editor: Ridgeley Lange, Department of Mathematics,
Hampton University, Hampton, VA 23668
804-727-5909

BIOLOGY

Chair: Harry F. Painter, 8324 The Midway, Annandale, VA 22003
@PHONE = 703-978-3343
JMPHFP@AOL.COM

Secretary: Michael T. Mengak, Box 2383 Ferrum College, Ferrum VA 24088
540-365-4373 (O) 540-365-0092 (H) FAX 540-365-4375
MMENGAK@FERRUM.EDU

Council Representative: Carolyn M. Conway (1996)
Dept. of Biology, Box 842012, Va Commonwealth Univ. Richmond, VA 23284-2012
804-828-1562 FAX: 804-828-0503
CCONWAY@SATURN.VCU.EDU

Editor: Arthur F. Conway, Department of Biology,
 Randolph-Macon College, P.O. Box 5005, Ashland, VA 23005-5505
 804-752-3720 FAX: 804-752-7345 or
 804-752-7231

ACONWAY@RMC.EDU

Vice Chair: Harold J. Grau
 50 Shoe Lane, Newport News, VA
 804-594-7946 FAX 804-594-7919
 HGRAU@CNU.EDU

BIOMEDICAL AND GENERAL ENGINEERING

Chair: Michael H. Gregg, Engineering Fundamentals Division,
 VPI&SU, Blacksburg, VA 24061-0218
 540-231-9544 FAX: 540-231-6903
 GREGGMH@VTVM1.CC.VT.EDU

Secretary: William P. Harrison, Engineering Fundamentals Division
 VPI&SU, Blacksburg, VA 24061-0218
 540-231-6555 FAX: 540-231-6903
 BIL_NEL@VTVM1.CC.VT.EDU

Council Representative: John B. Crittenden, Engineering Fundamentals Division,
 VPI&SU, Blacksburg, VA 24061-0218
 540-231-6555 FAX: 540-231-6903
 BCRITTEN@VTVM1.CC.VT.EDU

Editor: David L. Livingston, VA Western Comm. College, Division of Engr/Industrial Tech.,
 P. O. Box 14007, Roanoke, VA 24038
 540-857-6261 FAX: 540-857-6944
 DLLPHDPE@ROANOKE.INFI.NET

BOTANY

Chair: Leonard Morrow, P.O. Box 7447, JSRCC, Richmond, VA 23221
 804-371-3692 FAX: 804-556-2092

Secretary: J. Rex Baird, Clinch Valley College, Wise, VA 24293
 540-328-0201 FAX: 540-328-6540

Council Representative: Marion Blois Lobstein (1998)
 NVCC-Manassas Campus, 6901 Sudley Road, Manassas, VA 22110
 703-257-6643 (O) 703-536-7150 (H) FAX:
 MBLOBST@MNSINC.COM

Editor: Harold S. Adams, 1021 Cliftwood Cir., Clifton Forge, VA 24422
 540-862-4246 (O), 540-862-1251 (H) 540-862-2398
 DLADAMS@VCCS.CENT

Vice Chair: R. Jay Stipes, Dept. of Plant Pathology, Physiology, and Weed Science, Virginia Tech, Blacksburg, VA 24061-0331
 540-321-7479
 TREEDR@VT.EDU

CHEMISTRY

Chair: Donald D. Shillady, P.O. Box 842006, Virginia Commonwealth University, Richmond, VA 23284-2006
 804-828-7508 FAX: 804-828-8599
 DSHILLAD@CABELL.VCU.EDU

Secretary: Gary L. Long, Dept. of Chemistry, VPI&SU, Blacksburg, VA 24061-0212
 540-231-7575 FAX: 540-231-3255
 GLONG@VT.EDU

Council Representative: George W. Mushrush (1997)
 Chemistry Department, George Mason University, Fairfax, VA 22030
 703-993-1080 FAX: 703-993-3193

Editor: Albert T. Sneden, Department of Chemistry, Box 2006, Virginia Commonwealth University, Richmond, VA 23284-2006
 804-367-1298 FAX: 804-367-8599
 ASNEDEN@SATURN.VCU.EDU

COMPUTER SCIENCE

Chair: Rita D'Arcangelis, Department of Computer Science, Mary Washington College, Fredericksburg, VA 22401-5358
 540-654-1321 540-654-1068
 RMD@MWC.EDU

Secretary: Rhonda Eller-Meshreki, Department of Computer Science, Randolph-Macon College, P.O. Box 5005, Ashland, VA 23005-5505
 804-752-7272
 RELLERME@RMC.EDU

Council Representative: Robert A. Willis, Jr. (1997)
 Department of Computer Science, Hampton University, Hampton, VA 23668
 804-727-5082 FAX: 804-727-5390
 WILLIS@WILLIS.CS.HAMPTON.EDU

Editor: Larry Morell, Department of Computer Science,
Hampton University, Hampton, VA 23668
804-727-5556
MORELL@CS.HAMPTONU.EDU

FAX: 804-727-5390

EDUCATION

Chair: Bea L. Taylor, 4413 Woods Edge Ct., Chantilly, VA 22021
703-378-8810 703-631-5590
BLTAYLOR@PEN.K12.VA.EDU

Secretary: Richard T. Strauss, Maury H.S., 322 Shirley Ave., Norfolk, VA 23517
757-441-2611 FAX: 757-441-1285
RSTRAUSS@PEN.K12.VA.EDU

Council Representative: Pamela C. Turpin (1998)
1120 Woodcrest Dr., Bedford, VA 24523
540-586-8067 (H)
PTURPIN@ACC.ROANOKE.EDU

Editor: Alvin M. Pettus, Department of Secondary Education,
James Madison University, Harrisonburg, VA 22807
540-568-6486 or 3887 FAX: 540-568-3780
PETTUSAM@JMU.EDU

ENGINEERING (See Biomedical and General Engineering)

ENVIRONMENTAL SCIENCE

Chair: Douglas Mose, Department of Chemistry, George Mason University,
Fairfax, VA 22030
703-993-1068 FAX: 703-273-2282
DMOSE@GMU.EDU

Secretary: Tess Connor, Dept. of Biology, George Mason, University, Fairfax,
VA 22030
703-993-1036 FAX: 703-993-1046
TCONNOR@OSFI.GMU.EDU

Council Representative: Michael L. Bass (1997)
Department of Environmental Science and Geology,
Mary Washington College, Fredericksburg, VA 22401
540-654-1424 FAX: 540-654-1018

Editor: Brian W. Moores, Department of Chemistry, 328 Copley Science Center,
P.O. Box 5005, Randolph Macon College, Ashland, VA 23005-5505
804-752-7245 FAX: 804-752-4724

Vice Chair: R. Christian Jones, Department of Biology,
George Mason University, Fairfax, VA 22030
703-993-1127 FAX: 703-993-1046
RCJONES@WPGATE.GMU.EDU

GEOGRAPHY

Chair: Stephen E. Wright, Department of Geology and Geography,
James Madison University, Harrisonburg, VA 22807
540-568-6130 FAX: 540-568-6920
IN%FACSWRIGHT@JMU.EDU

Secretary: Stephen E. Wright, Department of Geology and Geography, James
Madison University, Harrisonburg, VA 22807
540-568-6130 FAX: 540-568-6920
IN%FACSWRIGHT@JMU.EDU

Council Representative: Stephen E. Wright (1996)
Department of Geology and Geography, James Madison University, Harrison-
burg, VA 22807
540-568-6130 FAX: 540-568-6920
IN%FACSWRIGHT@JMU.EDU

GEOLOGY

Chair: W. Cullen Sherwood, Department of Geology, James Madison Univer-
sity, Harrisonburg, VA 22807
540-568-6473 FAX: 540-568-7938
SHERWOWC@JMU.EDU

Secretary: Chester F. Watts, Dept. of Geology, Radford University, Radford,
VA 24142
540-831-5637 FAX: 540-831-6615
CWATTS@RUNET.EDU

Council Representative: Bruce K. Goodwin (1998)
Dept. of Geology, College of William & Mary, Williamsburg, VA 23187-8795
804-221-2443 FAX: 804-221-2093
BKGOOD@MAIL.WM.EDU

Vice Chair: Bruck K. Goodwin, Dept. of Geology, College of William & Mary, Williamsburg, VA 23187-8795

804-221-2443
BKGGOOD@MAIL.WM.EDU

FAX: 804-221-2093

MATERIALS SCIENCE

Chair: Mike Stawovy, Department of Materials Science and Engineering, VPI&SU, Blacksburg, VA 24061-0237
MSTAWOVY@VTVM1.CC.VT.EDU

Secretary: Paul Cantonswine, Dept. of Materials Science & Engineering, University of Virginia, Charlottesville, VA 22903

FAX: 804-982-5677

PEC4N@VIRGINIA.EDU

Council Representative:

Editor: Thomas Kuhr, Department of Materials Science and Engineering, Virginia Tech, Blacksburg, VA 24061-0237

Vice Chair: James Groves, Department of Materials Science and Engineering, UVA, Charlottesville, VA 22903

804-982-2797

FAX: 804-982-5677

JFGBE@VIRGINIA.EDU

MEDICAL SCIENCES

Chair: Craig Kinsley, Department of Psychology, University of Richmond, Richmond, VA 23173

804-289-8132

FAX: 804-289-8943

KINSLEY@URVAX.URICH.EDU

Secretary: Jenny Wiley, Department of Pharmacology/Toxicology, MCV/VCU, Box 980613, Richmond, VA 23298-0613

804-828-2067

FAX: 804-828-2117

JWILEY@GEMS.VCU.EDU

Council Representative: Amelia Compton, (1999)

Dept. of Psychology, University of Richmond, Richmond, VA 23173

804-289-8123

FAX: 804-289-8943

COMPTON@URVAX.URICH.EDU

Vice Chair: Roman J. Miller, Department of Biology,
Eastern Mennonite College, Harrisonburg, VA 22801
540-432-4412
MILLERRJ@EMU.EDU

FAX: 540-432-4488

MICROBIOLOGY AND MOLECULAR BIOLOGY

Chair: J. Keith McClung, Radford University, Radford, VA 24142-6931
540-831-5642

MCCLUNG2QMAIL.BIOLOGY.RUNET.EDU

Secretary: Charles H. O'Neal, Department of Microbiology & Immunology,
Box 980678, MCV/VCU, Richmond, VA 23298-0678
804-786-9699

FAX: 804-786-9946

Council Representative: Judy H. Niehaus, Box 6931, Radford University,
Radford, VA 24142

540-831-5146 (o) 540-951-3556 (H)

FAX: 540-831-6615

JNIEHAUS@RUNET.EDU

Editor: Gail E. Christie, Department of Microbiology & Immunology, Box
980678 MCV/VCU, Richmond, VA 23298-0678
804-828-9093

FAX: 804-828-9946

CHRISTIE@GEMS.VCU.EDU

NATURAL HISTORY AND BIODIVERSITY

Chair: C. Barry Knisley, Department of Biology,
Randolph-Macon College, Ashland, VA 23005
804-752-7254

FAX: 804-752-4724

BKNISLEY@RMC.EDU

Secretary: Werner Wieland, Dept. of Biological Sciences, Mary Washington
College, Fredericksburg, VA 22401-5358

540-654-1426

FAX: 540-654-1081

WWIELAND@paprka.mwc.edu

Council Representative: Michael Kosztarab, Dept. of Entomology, VPI & SU,
Blacksburg, VA 24061-0319
540-231-6773 (O)

Editor: Joseph C. Mitchell, Department of Biology,
University of Richmond, Richmond, VA 23173
804-740-7086

804-289-8233

MITCHELL@URVAX.URICH.EDU

PSYCHOLOGY

Chair: W. George Jones, Department of Psychology,
 Danville Community College, 1008 S. Main Street, Danville, VA 24541
 804-797-8485 or
 797-3553 (O) 804-792-3440 (H) FAX: 804-792-6810

Secretary: Perry M. Duncan, Department of Psychology,
 Old Dominion University, Norfolk, VA 23529
 757-683-4447 (O) 757-627-1178 (H) FAX: 804-683-5087
 PMD200F@VIPER.MGB.ODU.EDU

Council Representative: Robert A. Berquist (1999)
 Psychology-CC, Tidewater Community College,
 1428 Cedar Road, Chesapeake, VA 23320
 804-490-8058 (O) 804-527-7329 (H) FAX: 804-549-5173

Editor: Jeffrey Pickens, Department of Psychology, James Madison University,
 Harrisonburg, VA 22807
 540-568-7900 (O) 540-434-8303 (H) FAX: 540-568-3322
 JPICKENS@VAX1.ACS.JMU.EDU

STATISTICS (VAS Chapter, American Statistical Association)

Chair: Don Ramirez, UVA
 FAX:

Secretary: Robert E. Johnson, Department of Mathematical Sciences, Virginia
 Commonwealth University, Richmond, VA 23284-2014
 804-828-1301 FAX: 804-828-8785
 RJOHNSON@VCU.EDU

Council Representative: Don Jensen, VPI&SU

FAX:

Editor: Dayanand Naik

FAX:

STANDING COMMITTEES

ARCHIVES COMMITTEE

Chair: Golde I. Holtzman, Department of Statistics (1999)
VPI & SU, Blacksburg, 24061-0439.

540-231-8356 (O)

FAX 540-231-3863

HOLTZMAN@VT.EDU

Martha Roane, Department of Plant Pathology, (1998)
VPI & SU, Blacksburg 24061

540-231-6361 (O) 540-552-2260 (H)

Vera Remsburg (1997)
236 Barter Drive, Box 1230, Abingdon 24210
540-628-6236 (H)

Academy Archivist, Stephen Zietz(Ex officio)
Head, Special Collections, ATTN: VAS Archives,
1020 Newman Library, VPI & SU, Blacksburg 24061-0434
540-231-9205 (O) FAX: 540-231-9263
ZIETZ@VTVM1.CC.VT.EDU

William P. Harrison, Engineering Fundamentals, (1998)
VPI & SU, Blacksburg 24061-0218
540-231-6555 (O) 540-552-2427 (H)

AWARDS COMMITTEE

Chair: Robert E. Johnson, Department of Mathematical Sciences, (1998)
Virginia Commonwealth University, Richmond 23284-2014
804-367-1301 (O) FAX: 804-367-8785
RJOHNSON@RUBY.VCU.EDU

Lisa T. Alty, Department of Chemistry (1997)
Washington and Lee University, Lexington 24450
540-463-8927 (O) 540-464-8272 (Dept.) 804-384-7356 (H)
ALTU.L@FSSCIENCES.WLU.EDU

W. R. (Rick) West, Jr. (1997)
6806 Lakewood Drive, Richmond 23229-6931
804-288-5796 (H)

Richard B. Brandt, Department of Biochemistry, (1997)
MCV/VCU, Box 614, Richmond 23298
804-786-0104 (O) 804-355-0436 (H) FAX: 804-786-0104
BRANDT@GEMS.VCU.EDU

COMMITTEE ON THE ENVIRONMENT

Chair: Michael L. Bass, Department of Environmental Sciences and Geology, Mary Washington College, Fredericksburg 22401 (1998)
 540-899-4358 (O) 540-972-2453 (H) FAX: 540-899-4766

J. J. Murray, Department of Biology, Gilmer Hall, University of Virginia, Charlottesville 22903-2477 (1998)
 804-982-5771 (O) 804-982-5474 (Dept.) 804-973-6693 (H)

David J. Moore, Biology Department, Radford University, Radford 24142 (1996)
 540-831-5658 (O)

Robert K. Rose, Department of Biological Sciences, Old Dominion University, Norfolk 23529-0266 (1997)
 757-683-3595 (O) 757-683-4202 (Dept.) FAX: 757-683-5283

Fred Stemple, Department of Biology Tidewater Community College, Virginia Beach 23456 (1997)
 757-427-7191 (O) 757-498-8068 (H) FAX: 757-427-7326

James H. Martin, Department of Biology-PRC, J. Sargeant Reynolds Community College, Box 85622, Richmond 23285-5622 (1998)
 804-371-3064 (O) 804-262-0517 (H) FAX: 804-371-3311
 srmartj@jsr.cc.va.us

CONSTITUTION AND BYLAWS COMMITTEE

Co-Chair: Michael L. Bass, Department of Environmental Sciences and Geology, Mary Washington College, Fredericksburg 22401 (1998)
 540-899-4358 (O) 540-972-2453 (H) FAX: 540-899-4766

Co-Chair: Gerald R. Taylor, Jr., Department of Physics, James Madison University, Harrisonburg 22807 (1998)
 540-568-6109 or -6328 (O) 540-433-1251 (H)
 TAYLORGR@JMU.EDU

R. Dean Decker, Department of Biology, University of Richmond, Richmond 23173 (1998)
 804-289-8231 (O) 804-282-1631 (H)

Michael Lyle, Department of Geology, Tidewater Community College, Virginia Beach 23456 (1997)
 757-427-7189 (O)
 LYLEM@VCCS

Lisa T. Alty, Department of Chemistry, (1997)
 Washington and Lee University, Lexington 24450
 540-463-8927
 ALTY.1@FS.SCIENCES.WLU.EDU

FINANCE AND ENDOWMENT COMMITTEE

(According to Bylaw Article III, Section 5, Paragraph D, one member of the Trust Committee is a member of the Finance and Endowment Committee; see Paul J. Homsher).

Co-Chair: Arthur W. Burke, Jr., Executive Secretary-Treasurer, (Non-voting)
 Virginia Academy of Science, Science Museum of Virginia,
 2500 W. Broad St., Richmond 23220
 804-367-8971 (O) 804-746-3283 (H) FAX: 804-371-3311

Co-Chair: Paul J. Homsher, Director of Development, Dean's Office, College of Sciences, (1997)
 Old Dominion University, Norfolk 23529-0163
 757-683-3319 (O) 757-497-6833 (H)
 HOMSHER@CS.ODU.EDU

Golde I. Holtzman, Department of Statistics, (1997)
 VPI & SU, Blacksburg 24061-0439
 540-231-8356 (O) FAX: 540-231-3863
 HOLTZMAN@VT.EDU

FUND RAISING COMMITTEE

Chair: James P. O'Brien, (1997)
 Psychology-VBC, Tidewater Community College
 1700 College Crescent, Virginia Beach 23456
 757-427-7171 (O)
 or 7207 (Secy) 757-423-4113 (H) FAX: 757-427-7326

R. Dean Decker, Department of Biology, (1999)
 University of Richmond, Richmond 23173
 804-289-8231 (O) 804-282-1631 (H) FAX: 804-289-8233
 DECKER@URVAX.URICH.EDU

Golde I. Holtzman, Department of Statistics, (1997)
 VPI & SU, Blacksburg 24061-0439
 540-231-8356 (O) 540-951-7259 (H) FAX: 540-231-3863
 HOLTZMAN@VT.EDU

Preston H. Leake (1999)
 401 Delton Avenue, Hopewell 23860
 804-452-1743 (H)

Rosemary Barra, Department of Biological Sciences, (1997)
 Mary Washington College, Fredericksburg 22401
 540-654-1414 (O) FAX: 540-654-1081
 RBARRA@MWC.EDU

Alan E. J. Branigan (1997)
 Law Office of Millen, White, Zolano, and Branigan, P.C.
 Arlington Court House, Plaza 1, Suite 1400,
 2200 Clarendon Blvd, Arlington 22201
 703-243-6333 (O) FAX: 703-243-6410

Ann M. Fabirkiewicz, Department of Chemistry (1997)
 Randolph-Macon Woman's College, Lynchburg 24503
 804-947-8495 (O) FAX: 804-947-8138
 AFAB@MAIN.RMWC.EDU

Gerald H. Johnson, Department of Geology, (1997)
 College of William and Mary, Williamsburg 23185
 757-221-2444 (O) FAX: 757-221-3540
 GHJOHN@EDUC.WM

Kenneth R. Lawless, Department of Materials Science, (1997)
 University of Virginia, Charlottesville 22903
 804-982-5645 (O) FAX: 804-982-5660
 KRL@VIRGINIA.EDU

Harold G. Marshall, Department of Biological Sciences, (1997)
 Old Dominion University, Norfolk 23529
 757-683-3595 (O) FAX: 757-683-5283
 HGM100F@VIPER.MGB.ODU.EDU

Ali I. Mohamed (Agriculture Research Station), (1997)
 Division of Agriculture, Virginia State University, P.O. Box 9259,
 Petersburg 23806
 804-524-6715 (O) 804-539-5099 (H) FAX: office or -5186
 NUTAGBIO@AOLCOM

Douglas C. Mose, Department of Chemistry, (1997)
 George Mason University, Fairfax 22030
 703-993-1068 (O) 703-273-2282 (H) FAX: 703-273-2282
 RCJONES@GMU.VAX

James L. Poland, Department of Physiology, (1997)
 MCV/VCU, Box 980551, Richmond 23298-0551
 804-828-9557 (O) 804-272-6374 (H) FAX: 804-828-7382
 POLAND@GEMS.VCU.EDU

Eleanor C. Santos (ODU Sports Medicine) (1997)
 1029 Swapscott Court, Virginia Beach 23454
 757-431-2659 (O) 757-721-9708 (H)

Robert A. Willis, Jr., Department of Computer Science (1998)
 Hampton University, Hampton 23668
 757-727-5082 (O); or (Secy: -5552) FAX: 757-727-5390
 WILLIS@WILLIS.CS.HAMPTONU.EDU

Robert A. Berquist, Psychology-CC, (1998)
 Tidewater Community College, 1428 Cedar Road, Chesapeake 23320
 757-549-5213 (O) 757-490-8058 (H) FAX: 757-549-5173
 TCBERQR@VCCSCENT

Richard B. Brandt, Department of Biochemistry, (1998)
 MCV/VCU, Box 614, Richmond 23298
 804-786-0104 (O) 804-355-0436 (H) FAX: 804-786-0104
 BRANDT@VCUVAX

Donald R. Cottingham (1998)
 910 Greenway Court # 1, Norfolk 23507
 757-622-6239 (H) FAX: 757-622-4412

Donald Falls (1998)
 1515 Helmsdale Drive, Richmond 23233
 1-800-488-9888 (BUS) 804-740-1492 (H) FAX: 804-644-1111

Elsa Q. Falls, Department of Biology, (1998)
 Randolph-Macon College, Ashland 23005
 804-752-7203 (O) 804-740-1492 (H) FAX: 804-752-7345
 EFALLS@RMC.EDU

Mary Frances Hobbs (1998)
 103 Kennedy Court, Mechanicsville 23111
 804-730-3395 (O: Atlee H.S.) 804-730-0913 (H)

C. Anthony Macera (1998)
 1444 Maharis Road, Virginia Beach 23455
 757-683-4462 (ODU) 757-460-1533 (H)

Maurice B. Rowe (1998)
 4121 Southaven Road, Richmond 23235
 804-272-2494 (H)

David L. Winters, Department of Chemistry, (1998)
 Tidewater Community College-VBC, 1700 College Crescent,
 Virginia Beach 23456
 757-427-7278 (O) FAX: 757-427-7326

Stephen E. Wright, Department of Geology and Geography, (1998)
 James Madison University, Harrisonburg 22807
 540-568-6130 (O) FAX: 540-568-6920
 FAC_SWRIGHT@JMU.VAX1

Arthur W. Burke, Jr. (Advisor to the Committee)
 9699 Shady Grove Road, Mechanicsville 23111
 804-287-4340 (O) 804-746-3283 (H)

D. Rae Carpenter, Jr. (Advisor to the Committee)
 Department of Physics and Astronomy, Virginia Military Institute,
 Lexington 24450
 540-464-7225 (O) 540-463-4948 (H)

Paul J. Homsher (Advisor to the Committee)
 Director of Development, Dean's Office, College of Sciences, Old Dominion
 University, Norfolk 23529-0163
 757-683-3319 or (O) 757-497-6833 (H)
 HOMSHER@CS.ODU.EDU

C. Roy Taylor (Advisor to the Committee)
 American Tobacco Co., P.O. Box 899, Hopewell 23860
 804-751-7725 (O)

JUNIOR ACADEMY OF SCIENCE COMMITTEE

Chair: Donald R. Cottingham (VJAS Director) (1997)
 910 Greenway Court # 1, Norfolk 23507
 757-622-6239 (H) FAX: 757-622-4412
 DON@DIRECT.NET

Jeannie Bishop, Liberty Middle School, (1999)
 13496 Liberty School Rd. Ashland, VA 23005
 804-752-6020 (O), 804-262-0339 (H)

Susan Booth, Kecoughtan High School (1999)
 522 Woodlawn Road, Hampton 23669
 757-892-5173 (O) 757-874-9301 (H) FAX: 757-892-5138

Richard B. Brandt, MCV/VCU (1998)
 Department of Biochemistry, Box 614, Richmond 23298
 804-828-0104 (O) 804-355-0436 (H) FAX: 804-828-0104
 BRANDT@VCU.VAX

Martha Chew, Turner-Asby High School (1998)
 46 Cantrell Avenue, Harrisonburg 22801
 540-828-2008 (O) 540-434-7535

Eric J. Collins, Wytheville Community College (1997)
 1000 E. Main St., Wytheville 24382
 540-223-4815 (O) 540-228-3066 (H)
 WCCOLLE@VCCS.CENT

Kathleen Frame (1998)
 13112 Nestlewood Court, Herndon 22071
 703-471-1134 (O) 703-476-6460 (H) FAX: 703-435-5582

Meg Gilman-King, Atlee High School (1999)
 Gillhope Farm, Route 1, Box 2085, Ashland 23005
 804-730-3395; Ext. 135 (O) 804-730-8959 (H)

Calvin C. Green (1999)
 5135 New Kent Highway, Quinton, 23141-2519
 804-932-4310 (H)

Mary Frances Hobbs, Atlee High School (1999)
 6296 Kennedy Court, Mechanicsville 23111
 804-343-6525 (O) 804-730-0913 (H) FAX: 804-343-6529

Cheryl Kayes, Open High School (1999)
 8031 Whittington Dr., Richmond, 23235
 804-285-1015 (O) 804-272-4310 (H)

Lee Larkin, Virginia Institute of Marine Science (VIMS) (1999)
 Gloucester, 23062
 757-642-7170 (O), 757-693-6274 (H), FAX: 757-642-7079

W. George Jones, Danville Community College (1999)
 1008 S. Main Street, Danville 24541
 804-797-8485 (O) 804-792-3440 (H) FAX: 804-797-8449

Joan H. Jones (1998)
 1810 Poplar Green Drive, Richmond 23233
 804-740-7606 (H)
 JOANJONES@AOL.COM

Dorothy S. Knowlton, Sci. Spvr., Arlington (1997)
 1426 North Quincy Street, Arlington 22207
 703-358-6166 (O) 703-536-3495 (H) FAX: 703-358-6188
 or 6186

John Kowalski, Roanoke Valley Governor's School (1999)
 2104 Grandin Road, Roanoke 24015
 540-981-2116 (O) 540-772-0657 (H)

Richard Krieg, VCU/MCV (1998)
 Dept. of Anatomy, Box 980-709, Richmond 23278-0709
 804-828-9540 (O) 804-740-7471 (H) FAX: 804-828-9477
 KRIEG@GEMS.VCU.EDU

Lee Larkin, Virginia Institute of Marine Science (VIMS) (1999)
 Gloucester, 23062
 757-642-7170 (O) 757-693-6274 (H) FAX: 757-642-7079

Preston H. Leake (1997)
 401 Delton Avenue, Hopewell 23860-1815
 804-452-1743 (H)

John Lieberman, Thomas Jefferson H.S. for Sci & Tech (1998)
 6560 Braddock Road, Alexandria 23212-2297
 703-750-8971 (O) 703-385-1163 (H)

Lisa L. Martin (Administrative Asst., VJAS)
 2404 Penniman Court, Richmond 23228
 804-367-8971 (O) 804-262-0517 (H) FAX: 804-371-6541

Carolyn Smith, Gloucester High School (1998)
 6680 Short Lane, Gloucester 23061
 804-693-2526 (O) 804-693-3913

Susan Steward, Arlington Public Schools (1999)
 5208 N. 30th St, Arlington 22207
 703-358-5450 (O) 703-237-8427 (H)

H.W. (Chuck) Straley, Woodberry Forest School (1998)
 P.O. Box 79, Woodberry Forest 22989
 540-672-3900 (O) 540-672-1634 (H)

Richard Strauss, Maury High School (1997)
 1308 Westmoreland Avenue, Norfolk 23508
 757-441-2611 (O) 757-489-2627 (H) FAX: 757-441-1589

James R. (Bobby) Surry, Prin., Newport News (1997)
 36 Newport Avenue, Newport News 23601
 757-428-6860 (O) 757-596-3301 (H)

Thomas Teates, VPI & SU (1997)
 4712 Brush Creek Road, Riner 24149-3416
 540-382-0542 (O) 540-342-7807 (H)
 TEATES@VT.EDU

Ertle Thompson, UVA, Ruffner Hall (1999)
 University of Virginia, Charlottesville, 22903
 804-924-0840 (O) 804-293-7330 (H)

Jane B. Turner, Addison Magnet Middle School (1997)
 1220 Fifth Street, NW, Roanoke 24016
 540-981-2681 (O) 540-342-7807 (H) FAX: 540-981-1174

Judy Upchurch (1997)
 200 Berkley St., Ashland, VA 23005
 804-752-6000 (O) 804-784-3233 (H)

Luella Van Newkirk (1997)
 1116 N. Rochester Street, Arlington 22205
 703-358-5400 (O) 703-536-5916 (H)

Sarah Ward-Petroske, Mag. Sch. for Health Prof. (1998)
 518 Fairfax Avenue, Norfolk 23507
 757-446-5975 (O) 757-627-2293 (H)

Joyce Weeks, Sci. Spvr., Hampton City Schools (1998)
 1819 Nickerson Avenue, Hampton 23663
 757-850-5259 (O) 757-826-2778 FAX: 804-850-5138

Jane Westbrook, Hermitage High School (1999)
 1307 Ware Rd. Richmond, 23229
 804-258-4281 (O), 804-285-4281 (H)

Thomasena Woods, Sci. Supvr, Newport News (1998)
 12465 Warwick Blvd., Newport News 23606
 757-591-4586 (O) 757-838-3722 (H)

1995-96 Virginia Junior Academy of Science Officers

President: Diameng Pa
 831 S. Monroe Street, Arlington 22204
 703-892-4374 (H)

Vice President: Meredith Bailey
 9012 Brieryle Road, Richmond 23229
 804-741-9522 (H)

Secretary: Jacob Foster
 167 Wright's Run Dr. White Post 22663
 540-869-5090(H)

LONG RANGE PLANNING COMMITTEE (Co-Chairs)

Co-Chair: Richard B. Brandt, Department of Biochemistry, (1998)
 Box 980614, MCV/VCU, Richmond 23298
 804-828-0104 (O) 804-355-0436 (H) FAX: 804-828-1473
 BRANDT@GEMS.VCU.EDU

Co-Chair: Thomas O. Sitz, Department of Biochemistry (1999)
 Virginia Tech, Blacksburg 24061-0308
 540-231-4970 (O) 540-231-6315(Leave Message)
 540-951-7332 (H) FAX: 540-231-9070
 TOSITZ@VT.EDU

Elsa Q. Falls, Department of Biology, (1998)
 Randolph-Macon College, Ashland 23005
 804-752-7203 (O) 804-740-1492 (H) FAX: 804-752-7231
 EFALLS@RMC.EDU

R. Dean Decker, Department of Biology, (1999)
 University of Richmond, Richmond 23173
 804-289-8231 (O) 804-282-1631 (H) FAX: 804-289-8233
 DECKER@URVAX.URICH.EDU

James P. O'Brien, Psychology-VBC, Tidewater Community College (1999)
 1700 College Crescent, Virginia Beach 23456
 757-427-7171 (O) or 7207 (Secy)
 804-423-4113 (H) FAX: 804-427-7326

James H. Martin, Editor, (1999)
The Virginia Journal of Science
 Department of Biology - PRC, J. Sargeant Reynolds Community College,
 Box 85622, Richmond 23285-5622
 804-371-3064 (O) 804-262-0517 (H) FAX: 804-371-3311
 SRMARTJ@JSR.CC.VA.US

Lisa Martin, Administrative Assistant (1999)
 Science Museum of Virginia, 2500 W. Broad St. Richmond, VA 23220
 804-367-8971 (O). 804-26200517 (H), FAX: 804-371-3311

Ertle Thompson, Ruffner Hall (1999)
 University of Virginia, Charlottesville, VA 22903
 804-924-0840 (O), 804-293-7330 (H)

Paula A. Collier (1999)
 RR# 1, Box 1845A, Crew, VA 23930
 804-645-1095,

FAX: 804-645-1998

D. Rae Carpenter, Jr.,
 Department of Physics and Astronomy,
 Virginia Military Institute, Lexington 24450
 540-464-7225 (O) 540-463-4948 (H)

(1999)

Harold G. Marshall, Department of Biological Sciences (1999)
 Old Dominion University, Norfolk, VA 23529-0266
 757-683-4204 (3595 (O), FAX: 757-683-5283
 HGM100F@VIPER.MGB.ODU.EDU

Donald R. Cottingham (VIAS Director)
 910 Greenway Court # 1, Norfolk 23507
 757-622-6239 (H)
 drc@jericho.com

(1999)

FAX: 757-622-4412

Vera B. Remsburg (1999)
 236 Barter Drive, Box 1230, Abingdon, VA 24210
 540-628-6236 (H)

Judy H. Niehaus, Dept. of Biology (1999)
 Radford University, Radford, VA 24142
 540-831-5146 (O), 540-951-3556 (H),
 JNIEHAUS@RUNET.EDU

FAX: 540-831-6615

Carolyn M. Conway, Biology Department (1999)
 Box 842012, Virginia Commonwealth University, Richmond, VA 23284
 804-828-1562 (O), FAX: 804-828-0503
 CCONWAY@SATURN.VCU.EDU

Arthur W. Burke, Jr., VAS Exec. Sec.-Trea. (1999)
 Science Museum of Virginia, 2500 W. Broad Street, Richmond, VA 23220
 804-3678971 (O). 804-746-3283 (H), FAX: 804-371-3311

Mary Frances Hobbs, Atlee High School
 6296 Kennedy Court, Mechanicsville 23111
 804-343-6525 (O) 804-730-0913 (H)

(1999)

FAX: 804-343-6529

MEMBERSHIP COMMITTEE

- Co-Chair: Scott H. Newton (1998)
 Virginia Department of Agriculture and Consumer Services
 (VDACS), Box 1163, Richmond 23209
 804-786-4435 (O) FAX: 804-371-7786
- Co-Chair: Joseph W. Rudmin, Department of Physics, (1999)
 James Madison University, Harrisonburg 22807
 540-568-6548
 FAC_RUDMIN@VAX1.CS.JMU.EDU
- Eleni Achilleos, Civil Engineering Technologies, (1997)
 Tidewater Community College, 1700 College Crescent,
 Virginia Beach 23456
 757-427-7311 FAX: 757-427-7326
- Kathryn E. Strozak, CEBAF, Mail Stop 16C, (1996)
 12000 Jefferson Avenue, Newport News 23606
 757-255-2408 (O) FAX: 757-249-7352
 STROZAK@CEBAF.GOV
- W. Peter Trower, Department of Physics, (1999)
 VPI & SU, Blacksburg 24061
 540-231-6230 (O) FAX: 540-231-7511
 TROWER@VTCC1.CC.VT.EDU
- Patricia L. Dementi, Biology Department, (1997)
 Randolph-Macon College, Ashland 23005
 804-752-7255 (O) 804-262-3312 (H)
- George C. Grant, Chemistry Department, (1997)
 Norfolk State University, Norfolk 23504
 757-683-8909
- Ali Mohamed (1997)
 Box 9259, Virginia State University, Petersburg 23806
 804-524-6715
- Preston H. Leake (1998)
 401 Delton Avenue, Hopewell 23860
 804-452-1743 (H)

NOMINATIONS AND ELECTIONS COMMITTEE

Chair: James P. O'Brien, Psychology-VBC, Tidewater Community College (1997)
1700 College Crescent, Virginia Beach 23456

757-427-7171 (O) or 7207 (Secy)

757-423-4113 (H)

FAX: 757-427-7326

Elsa Q. Falls, Department of Biology, (1998)

Randolph-Macon College, Ashland 23005

804-752-7203 (O) 804-740-1492 (H)

FAX: 804-752-7231

EFALLS@RMC.EDU

SECTION = Tom Sitz, Department of Biochemistry (1999)

Virginia Tech, Blacksburg, VA 24061-0308

540-231-4970 (O), 540-231-6315 (Dept. Off.)

540-951-7332 (H), FAX: 540-231-9070

TOSITZ@VT.EDU

PUBLICATIONS COMMITTEE

Co-Chair: James H. Martin, Editor,

(1999)

The Virginia Journal of Science

Department of Biology - PRC, J. Sargeant Reynolds Community College,

Box 85622, Richmond 23285-5622

804-371-3064 (O) 804-262-0517 (H)

FAX: 804-371-3311

SRMARTJ@JSR.CC.VA.US

Co-Chair: William Cunningham, Psychology (1999)

VBC, Tidewater Community College

1700 College Crescent, Virginia Beach, VA 23456

757-427-7207 (Secy)

FAX: 757-427-7326

Production Editor, **Virginia Scientists**

Nancy Patterson, Creative Services

(1997)

Tidewater Community College, 1700 College Crescent,

Virginia Beach 23456

757-427-7295

FAX: 757-427-7326

RESEARCH COMMITTEE

Chair: Arthur F. Conway, Biology Department,

(1999)

Randolph-Macon College, Ashland 23005

804-752-7293 (O) 804-746-2475 (H)

ACONWAY@RMC.EDU

Diane M. Spresser, Mathematics & Computer Science Dept.,

(1997)

James Madison University, Harrisonburg 22807

540-568-6184 (O)

W. John Hayden, Biology Department (1999)
 University of Richmond, VA 23173
 804-289-8232 (O), 804-794-2473 (H), FAX: 804-289-8233
 HAYDEN@URVAX.URICH.EDU

Marvin W. Scott, Department of Natural Sciences, (1999)
 Longwood College, Farmville 23901
 804-395-2569 (O)

Ali Mohamed, VA State University, (1998)
 P.O. Box 9259, Petersburg 23806
 804-524-6715

SCIENCE ADVISORY COMMITTEE

Chair: William L. Dewey, Research and Graduate Affairs (1999)
 MCV/VCU, Box 568, Richmond 23298
 804-828-0732 (O) FAX: 804-786-1664

R. Gerald Bass, Department of Chemistry, (1998)
 Virginia Commonwealth University, Richmond 23284
 804-828-1298

John Eaton, Associate Dean, Graduate School, (1997)
 VPI & SU, Blacksburg 24061-0325
 540-231-5645 (O) FAX: 540-231-3714
 EATON@VTVM1.CC.VT.EDU

George M. Simmons, Department of Biology, (1997)
 2119 Derring Hall, VPI & SU, Blacksburg 24061
 540-231-6407 540-231-6407 (Dept.) FAX: 540-231-9307

Anne C. Lund, Biology Department, (1997)
 Hampden-Sydney College, Hampden-Sydney 23901
 804-223-6175

Jan Winstead, Biology Department, (1997)
 James Madison University, Harrisonburg 22807
 540-568-6157 540-568-6225 (Department)

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 VPI & SU, Blacksburg 24061-0313
 540-231-5537 (O) 540-382-0542 (H) FAX: 540-231-9075
 TEATES@VT.EDU

Co-Chair: Maurice P. Lynch, Virginia Institute of Marine Science, (1999)
 Gloucester Point 23062
 804-642-7151 FAX: 804-642-6120
 MLYNCH@VIMS.EDUM.LYNCH.VIMS

Ertle Thompson, Ruffner Hall, (1998)
 University of Virginia, Charlottesville 22903
 757-924-0840 (O) 757-293-7330 (H)

R. Dean Decker, Department of Biology, (1999)
 University of Richmond, Richmond 23173
 804-289-8321 (O) 804-282-1631 (H) FAX: 804-289-8233

Al Costa, Department of Oceanography, (1997)
 1054 W. 47th Street, Old Dominion University, Norfolk 23529-0276
 757-683-5375 757-683-4285 (Dept.) FAX: 757-683-5303

David L. Winters, Department of Chemistry, (1997)
 Tidewater Community College, Virginia Beach 23456
 757-427-7278 FAX: 757-427-7326

W. George Jones, Dept. of Psychology, (1997)
 Danville Community College, 1008 S. Main St., Danville 24541
 804-797-3553, Ext. 285 804-792-3440 (H) FAX: 804-792-6810

Thomasena H. Woods, Science Supervisor, (1997)
 Newport News Public Schools, 12465 Warwick Blvd., Newport News 23606
 757-591-4586 (O) 757-838-3722 (H)

Rebecca L. Riester, NVCC-Loudoun (1998)
 1000 HFB Highway, Sterling 20164
 540-328-0201 (O) 540-328-6540

TRUST COMMITTEE

(According to Constitution Article XI, Section 3, the Trust Committee is composed of three accredited Members and shall elect its own Chair. According to Bylaw Article III, Section 5, Paragraph D, one member of the Trust Committee is a member of the Finance and Endowment Committee; see Paul J. Homsher).

Chair: D. Rae Carpenter, Jr., (1999)
 Department of Physics and Astronomy,
 Virginia Military Institute, Lexington 24450
 540-464-7225 (O) 540-463-4948 (H)

Maurice B. Rowe (1998)
 4121 Southaven Road, Richmond 23235
 804-272-2494 (H)

Paul J. Homsher, Director of Development, Dean's Office, (1997)
 College of Sciences, Old Dominion University, Norfolk 23529-0163
 757-683-3319 (O) 757-497-6833 (H)
 HOMSHER@CS.ODU.EDU

Arthur W. Burke, Jr., Executive Secretary-Treasurer, (Advisor)
 Virginia Academy of Science, Science Museum of Virginia,
 2500 W. Broad St., Richmond 23220
 804-367-8971 (O) 804-746-3283 (H) FAX 804-371-3311

Paula A. Collier, (Advisor)
 R. R. # 1, P.O. Box 1845A, Crew 23930
 804-645-1095 (H) 804-645-1998 (Fax)

VIRGINIA FLORA COMMITTEE

Chair: J. Rex Baird, Department of Biology, (1998)
 Clinch Valley College, Wise 24293
 540-328-0201 (O) 540-328-6540 (H)
 JRB@CLINCH.EDU

J. Christopher Lugwig, Division of Natural Heritage, (1998)
 203 Governor Street, Suite 402, Richmond 23219
 804-786-7951 (O)

Leonard Morrow (1998)
 P.O. Box 7447, Richmond 23221
 804-358-7355 (H)

Michael Hill, Biology Department, (1997)
 Bridgewater College, Bridgewater 22812
 540-828-2501 (O)

Bruce L. King, Biology Department, (1997)
 Randolph-Macon College, Ashland 23005
 804-752-7267 (O) 804-448-1063 (H)

Donna M. E. Ware, Department of Biology, (1997)
 College of William and Mary, Williamsburg 23185
 757-221-2213 (O) FAX: 757-221-6483

Marion B. Lobstein, NVCC - Manassas Campus, (1998)
 6901 Sudley Rd., Manassas 22110
 703-257-6643 (O) 703-536-7150 (H)

FAX: 703-368-1069 (O)

FAX: 703-534-5713 (H)

SPECIAL COMMITTEE ON PUBLIC AFFAIRS

Chair: Ralph P. Eckerlin, Natural Sciences Division, (1997)
 Northern Virginia Community College, Annandale 22003
 703-323-3234 (O) FAX: 703-323-3215

H. Stephen Adams, Department of Biology, (1998)
 Dabney S. Lancaster Community College, Clifton Forge 24422
 540-862-4246 (O) 540-862-1251 (H) FAX: 540-862-2398

Eugene B. Barfield, Archaeology, (1997)
 Jefferson National Forest, 210 Franklin Road SW, Roanoke 24001
 540-982-6248 (O) 540-345-9706 (H) FAX: 540-982-4656

Eric J. Collins, Wytheville Community College, (1998)
 1000 E. Main St., Wytheville 24382
 540-228-5541 (O) 540-228-3066 (H)

Beverly K. Hartline, CEBAF, MS 16C, (1998)
 12000 Jefferson Avenue, Newport News 23606
 757-249-7567 FAX: 757-249-7352
 HARTLINEB@CEBAF.GOV

Harold G. Marshall, Department of Biology, (1997)
 Old Dominion University, Norfolk 23529
 757-683-4204 (3595) (O) FAX: 757-683-5283
 HGM100F@VIPER.MGB.ODU.EDU

Cathy McConaughy, Department of Oceanography, (1998)
 1054 W. 47th Street, Old Dominion University, Norfolk 23529-0276
 804-683-5140 (O) 804-683-4285 (Dept.) FAX: 804-683-5303

Penny Pagona, Industrial Engineering and Management, (1997)
 Tidewater Community College, 1700 College Crescent,
 Virginia Beach 23456
 757-427-7311 (O) FAX: 757-427-7326

Fred Stemple, Department of Biology (1998)
 Tidewater Community College, 1700 College Crescent,
 Virginia Beach 23456
 804-427-7191 (O) 804-498-8068 (H) FAX: 804-427-7326

Sandra P. Welch, Dept. of Pharmacology and Toxicology, (1998)
 MCV/VCU, Box 613, Richmond 23298-0613
 804-786-8406 (O) FAX: 804-371-7519
 SWELCH@VCUVAX

SPECIAL COMMITTEE ON 75TH ANNIVERSARY

Chair: Golde I. Holtzman, Department of Statistics, VPI & SU, Blacksburg
 24061-0439
 540-231-8356 (O) FAX: 540-231-3863
 HOLTZMAN@VT.EDU

Richard B. Brandt, Department of Biochemistry,
 MCV/VCU, Box 980614, Richmond 23298
 804-828-0104 (O) 804-355-0436 (H) FAX: 804-828-0104
 BRANDT@GEMS.VCU.EDU

Greg C. Cook
 Tidewater Community College,
 7000 College Dr., Portsmouth 23703
 757-484-2121, Ext. 461 (O) FAX: 757-483-9169
 GCOOKG@INFI.NET

Elsa Q. Falls, Department of Biology,
 Randolph-Macon College, Ashland 23005
 804-752-7203 (O) 804-740-1492 (H) FAX: 804-752-7345
 EFALLS@RMC.EDU

James P. O'Brien, Psychology-VBC,
 1700 College Crescent, Tidewater Community College,
 Virginia Beach 23456
 757-427-7171 (O) or
 427-7207 (Secy) 757-423-4113 (H) FAX: 757-427-7326

Charles H. O'Neal, Dept. of Microbiology/Immunology
 MCV/VCU, Box 478, Richmond 23298
 804-828-9699 (O) 804-798-8030 (H)

Vera Remsburg
 236 Barter Drive, Box 1230, Abingdon 24210
 540-628-6236 (H)

Thomas O. Sitz, Department of Biochemistry & Anaerobic Microbiology, VPI & SU, Blacksburg 24061-0308

540-231-4970 (O) 540-231-6315(Leave Message)
540-951-7332 (H) FAX: 540-231-9070

Gerald R. Taylor, Jr., Physics Department,
James Madison University, Harrisonburg 22807

540-568-6109 (O) 540-568-6328 (O) 540-433-1251 (H)

Thomas G. Teates, 305 Memorial Hall
VPI & SU, Blacksburg 24061-0313

540-231-5537 (O) 540-382-0542 (H) FAX: 540-231-9075
TEATES@VTVM1

Ertle Thompson, Ruffner Hall,
University of Virginia, Charlottesville 22903

804-924-0840 (O) 804-293-7330 (H)

R. Dean Decker, Department of Biology,
University of Richmond, Richmond 23173

804-289-8231 (O) 804-282-1631 (H) FAX: 804-289-8233

**SPECIAL COMMITTEE ON LOCAL ARRANGEMENTS FOR THE 1997
ANNUAL MEETING AT VIRGINIA POLYTECHNIC INSTITUTE and STATE
UNIVERSITY**

John L. Hess, Department of Biochemistry, Virginia Tech, Blacksburg, VA
24061-0308

540-231-5336 FAX: 540-231-9070
JLHESS@VT.EDU

Tom O. Sitz, Department of Biochemistry, Virginia Tech, Blacksburg, VA 24061-0308

540-231-4970, FAX: 540-231-9070
TOSITZ@VT.EDU

Please contact Drs. Hess or Sitz for a complete list of the local arrangements committee.

VIRGINIA ACADEMY OF SCIENCE PRESIDENTS

Ivey F. Lewis ∞	1923-24	Jackson J. Taylor	1962-63
James Lewis Rowe ∞	1924-25	Foley F. Smith ∞	1963-64
Robert E. Loving ∞	1925-26	S. S. Obenshain	1964-65
J. Shelton Horsley ∞	1926-27	Roscoe D. Hughes ∞	1965-66
Donald W. Davis ∞	1927-28	Stanley E. Williams ∞	1966-67
William Moseley Brown ∞	1928-29	James W. Cole, Jr.	1967-68
Garnet Ryland ∞	1929-30	Paul B. Seigel	1968-69
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I. D. Wilson ∞	1931-32	Maurice B. Rowe	1970-71
T. McN. Simpson, Jr.	1932-33	Edward F. Turner, Jr. ∞	1971-72
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William T. Sanger ∞	1934-35	Stanley Ragone ∞	1973-74
Ida Sitler	1935-36	E. L. Wisman	1974-75
H. E. Jordan	1936-37	Arthur W. Burke	1975-76
D. Maurice Allan	1937-38	W. Allan Powell	1976-77
Earl B. Norris	1938-39	Ralph A. Lowry	1977-78
Ruskin S. Freer ∞	1939-40	Dale V. Ulrich	1978-79
Wortley R. Rudd ∞	1940-41	Vera B. Remsburg	1979-80
George W. Jeffers ∞	1941-42	Kenneth R. Lawless	1980-81
Marcellus H. Stow ∞	1942-43	Donald G. Cochran	1981-82
W. Catesby Jones ∞	1943-44	Ertle Thompson	1982-83
Robert F. Smart	1944-45	Harold M. Bell	1983-84
Hiram R. Hanmer	1945-46	Frank B. Leftwich	1984-85
Arthur Bevan	1946-47	R. Gerald Bass	1985-86
Jesse W. Beams ∞	1947-48	J. J. Murray	1986-87
Sidney S. Negus ∞	1948-49	William L. Banks, Jr.	1987-88
Boyd Harshbarger	1949-50	Stewart A. Ware	1988-89
Guy W. Horsley	1950-51	Michael Bass	1989-90
Paul Patterson	1951-52	Richard B. Brandt	1990-91
Lloyd C. Bird ∞	1952-53	Gerald R. Taylor, Jr.	1991-92
Allan T. Gwathney ∞	1953-54	Golde I. Holtzman	1992-93
Irving G. Foster	1954-55	James P. O'Brien	1993-94
Walter S. Flory, Jr.	1955-56	Elsa Q. Falls	1994-95
E. S. Harlow	1956-57	Tom Sitz	1995-96
William G. Guy ∞	1957-58	R. Dean Decker	1996-97
John C. Forbes ∞	1958-59		
William M. Hinton	1959-60		
Wilson B. Bell ∞	1960-61		
Horton H. Hobbs, Jr. ∞	1961-62		

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B. W. Cooper ∞	1950
Grover Everett ∞	1951
Thelma C. Heatwole ∞	1952-60
W. W. Scott	1960-64
E. L. Wisman	1964-72
Lee Anthony	1972-75
John L. Hess	1975-78
A. B. Neimeyer	1978-80
R. Dean Decker	1980-91
Donald R. Cottingham	1991-

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Susie Floyd ∞ and George W. Jeffers ∞	1968
Hubert J. Davis	1969
Thelma C. Heatwole ∞	1970
Martha Lipscomb Walsh ∞	1971
Loyde C. Byrd ∞ and Rodney C. Berry	1972
Edgar V. Russell, Jr. and James W. Cole, Jr.	1973
Vera B. Remsburg and E. L. "Chick" Wisman	1974

Virginia C. Ellet and Blanton M. Bruner	1976
Lee S. Anthony	1977
John L. Hess	1978
A. B. Niemeyer, Jr.	1980
Dawn Campbell ∞	1983
Bernie J. Kozakowski	1984
Dallas W. Cocke ∞	1985
Eleanor Lewis Tenney ∞	1988
F. Lee Larkin and Lisa L. Martin	1992
R. Dean Decker	1995

HORSLEY RESEARCH AWARD

Carl C. Speidel ∞	1927	Claude P. Talley and	
John H. Yoe ∞	1928	Gerald R. Taylor, Jr.	1962
J. C. Street	1929	H. A. David	1963
H. E. Jordan and		E. Rae Harcum	1964
Carl C. Speidel	1930	D. Kuhlmann-Wilsdorf	1965
E. C. Stevenson	1931	Frank A. Vingiello	1966
James H. Smith	1932	O. R. Rodig and	
S. A. Wingard	1933	Galal Zanati	1967
E. P. Johnson	1934	H. H. Hobbs, P. C. Holt ∞ ,	
Margaret Hess	1935	and Margaret Walton ∞ . . .	1968
Alfred Chanutin	1936	A. J. McCaffery, P. N. Schatz,	
R. G. Henderson	1937	and T. E. Lester	1969
S. G. Bedell	1938	I. Gordon Fels	1970
M. J. Murray and		L. R. Durden, L. H. Slack, and	
Forrest F. Cleveland	1939	P. R. Eusner	1971
Walter C. Gregory	1940	I. J. Good and	
Charles Ray	1941	R. A. Gaskins	1972
No Award	1942	Larry Taylor, J. C. Dillard, and	
J. B. Meyer	1943	J. H. Burness	1973
J. Gerbert Taylor	1944	Kuldip P. Chopra	1974
No Award	1945	Roddy V. Amenta	1975
Boyd Harshbarger	1946	Douglas W. Ogle and	
D. B. DeJury	1947	Peter Mazzeo	1976
Henry Leidheiser, Jr.	1948	Henry W. Gould	1977
Walter S. Flory	1949	K. L. Reifsnider and	
Erling S. Hegre	1950	K. D. O'Brien	1978
D. B. Duncan	1951	William L. Dewey	1979
D. R. H. Gourley	1952	C. R. Terman and	
Stephen Burko and		R. J. Huggett	1980
Frank L. Hereford	1953	L. E. Jarrard	1981
Lynn D. Abbott, Jr. and		Joyce G. Foster,	1982
Mary J. Dodson	1954	Harold E. Burkhart, and	
Albert W. Lutz, Jr. and		Peter T. Sprinz	1983
A. E. B. Reid	1955	R. W. Berlien, G. Colmano, and	
M. C. K. Tweedie	1956	G. Nunn	1984
R. A. Bradley, D.E.W. Schumann,		Milton M. Sholley,	
and W. H. Lewis	1957	Gilda P. Ferguson,	
C. Tyler Miller, Jr. and		Hugo R. Seibel,	
K. R. Lawless	1958	James L. Montour, and	
Dorothy L. Crandall	1959	John D. Wilson	1985
Lawrence I. Miller,	1960	Robert F. Johnson	1986
		Richard B. Brandt	1987
Irving R. King, Billy W. Sloope,		Muriel Lederman	1988
and Calvin O. Tiller	1961	George W. Mushrush	1989

R. Bruce Martin	1990
W. John Hayden	1991
(not awarded)	
W. Peter Trower	1993
William P. Harrison	1994

RECIPIENTS OF THE JEFFERSON GOLD MEDAL

Alfred Chanutin	1936
William B. Porter	1937
H. M. Phillips	1938
G. M. Shear and H. D. Ussery	1939

RECIPIENTS OF THE JEFFERSON PRIZE

L. G. Overholzer and J. H. Yoe	1940
*Allan T. Gwathmey	1941
R. N. Jefferson	1942
W. H. Hough	1943
Clinton B. Cosby	1944

MERITORIOUS SERVICE AWARDS

Ivey F. Lewis ∞ and William T. Sanger ∞	1956
No Award	1957
American Tobacco Co. Research Laboratory	1958
Lloyd C. Bird ∞	1959
No Award	1960
No Award	1961

No Award	1962
Allan T. Gwathmey ∞	

Sidney S. Negus ∞ and Jesse W. Beams ∞	1963
No Award	1964
Hiram R. Hanmer	1965

IVEY F. LEWIS DISTINGUISHED SERVICE AWARDS

Boyd Harshbarger	1966	Carolina Biological	
Russell J. Rowlett, Jr.	1967	Supply Company	1982
George W. Jeffers ∞	1968	No Award	1984
Walter S. Flory, Jr.	1969	Arthur W. Burke, Jr.	1985
Roscoe D. Hughes ∞	1970	Virginia C. Ellett	1985
Horton H. Hobbs, Jr. ∞	1971	Vera B. Remsburg	1986
No Award	1972	No Award	1987
No Award	1973	No Award	1988
Lynn D. Abbott, Jr.	1974	Ertle Thompson	1989
Edward S. Harlow	1975	Dale V. Ulrich	1990
D. Rae Carpenter, Jr.	1976	R. Dean Decker	1991
No Award	1977	Blanton M. Bruner	1992
Rodney C. Berry ∞	1978	Harold M. Bell	1993
Edward F. Turner, Jr. ∞ . . .	1979	Virginia Power	1994
Ruskin S. Freer ∞	1980	James H. Martin	1995
Philip Morris, Inc.			
(Presented to			
Bernard Kosakowski)	1981		

FELLOWS OF THE VIRGINIA ACADEMY OF SCIENCE

1970

Jesse Wakefield Beams ∞
 John Campbell Forbes ∞
 Thomas E. Gilmer ∞
 Boyd Harshbarger
 Roscoe D. Hughes ∞
 Clyde Young Kramer ∞
 J. Douglas Reid ∞
 William T. Sanger ∞

1971

Robert C. Carter ∞
 Edward S. Harlow
 Wilbert Harnsberger, Jr. ∞
 Alton M. Harville, Jr.
 Sterling M. Heflin ∞
 George W. Jeffers ∞
 Harry G. M. Jopson
 Everett L. Wisman

1972

Lynn De Forrest Abbot
 Rodney C. Berry ∞
 Lloyd C. Bird ∞
 Robert P. Carroll ∞
 James W. Cole, Jr.
 Walter S. Flory, Jr.
 Mary E. Kapp ∞
 Paul B. Siegel

1973

D. Rae Carpenter, Jr.
 Virginia C. Ellett
 Susie V. Floyd ∞
 A. B. Niemeyer, Jr.
 Edgar V. Russell, Jr. ∞
 Raymond L. Taylor

1974

Perry C. Holt
 William T. Ham, Jr.
 Leonard O. Morrow
 Robert F. Smart

1975

Franklin F. Flint ∞
 Horton H. Hobbs, Jr. ∞
 Michael Kosztarab
 Vera B. Remsburg
 William E. Trout, Jr. ∞
 W. Peter Trower
 Edward F. Turner, Jr. ∞

1976

Miles E. Hench
 Franklin D. Kizer
 Russell J. Rowlett, Jr.

1977

Bernard R. Woodson, Jr.

1978

Blanton M. Bruner
 A. W. Burke, Jr.
 Herbert McKennis, Jr. ∞
 W. Allan Powell
 Stanley Ragone ∞

1979

S. Gaylen Bradley
 Addison D. Campbell
 William M. Hinton ∞
 William L. Mengebier
 Maurice B. Rowe
 Jackson J. Taylor
 Ertle Thompson

1980

Dorothy Bliss
 Elizabeth Jackson
 Ralph A. Lowry
 James W. Midyette
 Helmut R. Wakeham

1981

Hubert J. Davis
 Frank L. Hereford
 Peter M. Mazzeo
 Warwick R. West, Jr.

1982

Dale V. Ulrich

1983

Donald G. Cochran
 Dallas W. Cocke ∞
 R. Dean Decker
 Mario R. Escobar ∞
 Charles O'Neal
 Martha L. Walsh ∞

1984

Dawn Campbell ∞
 Frank Leftwich
 J. J. Murray
 Stewart Ware

1985

Edward A. Crawford

1986

No Fellows Elected

1987

No Fellows Elected

1988

No Fellows Elected

1989

Kenneth R. Lawless

1990

James H. Martin

1991

Martha K. Roane

1992

Richard B. Brandt

1993

I. J. Good

1994

No Fellows Elected

1995

Golde I. Holtzman
 Gerald R. Taylor

HONORARY LIFE MEMBERS

Rodney C. Berry
 Loyd C. Byrd
 Blanton M. Bruner
 Walter S. Flory
 J. C. Forbes
 Edward S. Harlow
 Boyd Harshbarger
 Horton H. Hobbs, Jr.
 George W. Jeffers
 Mary E. Knapp
 Arthur H. Livermore

A. B. Massey
 Herbert McKennis, Jr.
 Glenn McMullen
 Beverly Orndorff
 Russell J. Rowlett
 Myron Shear
 Robert F. Smart
 I. D. Wilson
 Hubert J. Davis
 Martha L. Walsh

REGULAR MEMBERS

ACKERMANN, ERNEST C. COMPUTER SCIENCE DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401-5358	17	ATKINS, ROBERT C. CHEMISTRY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	05
ADAMS, HAROLD S. 1021 CLIFTWOOD CIRCLE CLIFTON FORGE, VA 24422	14	AUSTIN, JOHN M. 1001 SEVENTH AVE FARMVILLE, VA 23901	11
AITKEN, WILLIAM C. JR. 4809 BOXFORD RD VIRGINIA BEACH, VA 23456	10	AUSTIN, SAMUEL H. FONTAINE OFFICE PARK P.O. BOX 3758 CHARLOTTESVILLE, VA 22903	15
ALLEN, MILTON J. BIOPHYSICAL LAB, CHEMISTRY DEPT 1001 WEST MAIN ST, BOX 2006 RICHMOND, VA 23284	09	BABCOCK, SHARON K. BIOLOGY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	04
ALLEN, VIVIEN G. 2302 SLIDE RD UNIT 40 LUBBOCK, TX 79407-2252		BAILEY, CLIFTON 6507 DIVINE ST MCLEAN, VA 22101	12
ALTY, LISA TREVEY CHEMISTRY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450-0303	09	BAILEY, CHRISTOPHER M. GEOLOGY DEPT COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23187	08
AMENTA, RODDY V. 110 CRESCENT DRIVE HARRISONBURG, VA 22801	08	BAIRD, EDWARD R. JR. WILCOX AND BAIRD 210 MONTICELLO ARCADE NORFOLK, VA 23510	15
AMENTA, DONNA S. RR2 BOX 851 MCGAHEYSVILLE, VA 22840-9727	05	BAIRD, J. REX BIOLOGY DEPT CLINCH VALLEY COLLEGE WISE, VA 24293	14
AMMERMAN, DON J. 8384 CEDAR LANE KING GEORGE, VA 22485	02	BAKER, SUZANNE C. PSYCHOLOGY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	19
ANDERSON, BRUCE M. 1013 HIGHLAND CIRCLE BLACKSBURG, VA 24060	05	BANKES, DAVID A. 84 MAIN ST NEWPORT NEWS, VA 23601	14
ANDERSON, SAMUEL 6332 DARTMOUTH WAY VIRGINIA BEACH, VA 23464	05	BARBARO, RONALD D. 7036 LEE PARK COURT FALLS CHURCH, VA 22042	15
ANDERSON, JOHN E. 5 RIDGEVIEW CIRCLE HARTWOOD, VA 22406	04	BARBER, MICHAEL B. 821 FLORIDA ST SALEM, VA 24153	16
ANYIWO, JOSHUA C. PO BOX 6376 CHRISTOPHER NEWPORT UNIVERSITY NEWPORT NEWS, VA 23606	17		

REGULAR MEMBERS

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BARBER, PATRICK G. RT. 2, BOX 29-B KEYSVILLE, VA 23947	05	BECK, EDITH P. 1405 LANDON COURT LYNCHBURG, VA 24503	14
BARFIELD, EUGENE B. 414 WASHINGTON AVE, SW ROANOKE, VA 24016	16	BECK, JAMES D. 1977 VESONDER RD PETERSBURG, VA 23805	05
BARKER, R. EDWARD JR. MAT SCI DEPT, THORNTON HALL UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22903-2442	06	BELL, CHARLES E. JR. CHEMISTRY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23508	05
BARNES, DENNIS W. 12 GILDERSLEEVE RD CHARLOTTESVILLE, VA 22903	05	BELL, HAROLD M. 708 CIRCLE DR BLACKSBURG, VA 24060	05
BARRA, ROSEMARY BIOLOGICAL SCIENCES DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401	09	BENFIELD, E. F. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	04
BARTELS, BOBBYE HOFFMAN MATHEMATICS DEPT 50 SHOE LANE CHRISTOPHER NEWPORT UNIV. NEWPORT NEWS, VA 23606	11	BENTLEY, MICHAEL L. 312 N BROAD ST SALEM, VA 24153	11
BASKETT, RUSSELL C. 9282 JORDANS JOURNEY CT MECHANICSVILLE, VA 23111	04	BENTZ, EDWARD J. JR. 7915 RICHFIELD RD SPRINGFIELD, VA 22153	15
BASS, MICHAEL L. BIOLOGICAL SCIENCE DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401	04	BERG, LILLIAN D. 3319 DAUPHINE DR FALLS CHURCH, VA 22042	05
BATES, ROBERT C. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	03	BERG, JOSEPH W. 3319 DAUPHINE DR FALLS CHURCH, VA 22042	01
BAUER, DAVID F. MATH SCIENCE DEPT P.O. BOX 842014 VIRGINIA COMMONWEALTH UNIVER- SITY RICHMOND, VA 23284-2014	12	BETTENHAUSEN, LEE H. 12 CHADWICK CIR APT E NASHUA, NH 03062	07
BAUR, THOMAS S. BIOLOGY DEPT VIRGINIA MILITARY INSTITUTE LEXINGTON, VA 24450	04	BEVAN, DAVID R. DEPT OF BIOCHEMISTRY & NUTRI- TION VPI & SU BLACKSBURG, VA 24061	09
BAYLES, ROBERT A. CODE 6312 NAVAL RESEARCH LABORATORY WASHINGTON, DC 20375-5343	06	BHARDWAJ, HARBANS AGRI RESEARCH STATION BOX 9152 VIRGINIA STATE UNIVERSITY PETERSBURG, VA 23806	01
		BINNS, STEPHEN J. VDACS SEED LABORATORY 1 N 14TH ST, RM 238 RICHMOND, VA 23219	14

BIRCHARD, GEOFFREY F. BIOLOGY DEPT GEORGE MASON UNIVERSITY FAIRFAX, VA 22030	04	BOYD, JAMES N. 4634 BUTTE RD RICHMOND, VA 23235	02
BISHOP, JOHN W. BIOLOGY DEPT UNIVERSITY OF RICHMOND, VA 23173	15	BOYIRI, TELIH BOX 980540 RICHMOND, VA 23298-0540	09
BLATT, ELIZABETH 1831 GLENCOVE LANE RICHMOND, VA 23225	04	BRADIE, BRIAN CNU, 50 SHOE LANE NEWPORT NEWS, VA 23606-2998	02
BLISS, D. CRANDALL 322 SUMPTER ST LYNCHBURG, VA 24503	14	BRADLEY, ERIC L. BIOLOGY DEPT COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23185	04
BOARD, JOHN A. 1627 POPE AVE RICHMOND, VA 23227-3725	09	BRADLEY, TED BIOLOGY DEPT GEORGE MASON UNIVERSITY FAIRFAX, VA 22030	14
BOATMAN, SANDRA 1947 LAUREL MTN DR SALEM, VA 24153		BRAUN, WARREN L. 680 NEW YORK AVE HARRISONBURG, VA 22801	07
BOGGESE, ROBERT K. CHEMISTRY DEPT RADFORD UNIVERSITY RADFORD, VA 24142	05	BREIL, DAVID A. NATURAL SCIENCE DEPT LONGWOOD COLLEGE FARMVILLE, VA 23909	14
BOOTH, SUSAN 2210 EXECUTIVE DR SUITE D HAMPTON, VA 23666	04	BRENIZER, JACK S. JR DEPT OF MECH, AEROSPACE AND NUC ENGR UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22903-2442	07
BOUSQUET, WOODWARD S. 17E LEICESTER ST WINCHESTER, VA 22601-4613	14	BROWN, GARY L. DEPT BIOLOGICAL SCIENCES MARY WASHINGTON COLLEGE 1301 COLLEGE AVE FREDERICKSBURG, VA 22401-5358	04
BOWEN, JOANNE BOX 1776, DEPT ARCH. RESEARCH COLONIAL WILLIAMSBURG FOUNDA- TION WILLIAMSBURG, VA 23187-1776	16	BROWN, MARLEY R. III ARCH RESEARCH DEPT COLONIAL WILLIAMSBURG FDN PO BOX 1776 WILLIAMSBURG, VA 23187-1776	16
BOWEN, SCOTT E. PO BOX 980613 RICHMOND, VA 23298-0613	09	BROWN, BONNIE L. 5709 RIDGE POINT CT MIDLOTHIAN, VA 23112	01
BOWERS, BONNIE B. PSYCHOLOGY DEPT HOLLINS COLLEGE ROANOKE, VA 24020	10	BROWN, DAVID A. 6133 MERRIFIELD DR RICHMOND, VA 23225	05
BOWMAN, RICHARD L. PHYSICS DEPT BRIDGEWATER COLLEGE BRIDGEWATER, VA 22812	02		

REGULAR MEMBERS

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BRUBAKER, KENTON K. EASTERN MENNONITE COLLEGE HARRISONBURG, VA 22801	01	BYLES, RICHARD A. 3115 CAMPUS BLVD NE ALBUQUERQUE, NM 87106-2108	
BRUNKE, KATHLEEN BCFS DEPT 50 SHOE LANE CHRISTOPHER NEWPORT UNIV. NEWPORT NEWS, VA 23606	05	CALJOUW, CAREN RT 1, BOX 40 ROCKVILLE, VA 23146	14
BUDKE, EARL JR 1500 CONCORD APT # 1 COLONIAL HEIGHTS, VA 23834	08	CAMPBELL, F. HOWARD III GEOLOGY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	08
BUIKEMA, ARTHUR L. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	04	CARLSON, ROSEANN J. GEOLOGY DEPT TIDEWATER COMMUNITY COLLEGE 1700 COLLEGE CRESCENT VIRGINIA BEACH, VA 23456	08
BULL, ALICE LOUISE PO BOX 9633 HOLLINS COLLEGE ROANOKE, VA 24020-1633	04	CARSON, KEITH A. BIOLOGICAL SCIENCES DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529-0266	09
BULMER, WALTER ANNANDALE CAMPUS NORTHERN VIRGINIA COMM COLL ANNANDALE, VA 22003		CASTAGNOLI, NEAL JR CHEMISTRY DEPT 3103 HAHN HALL VPI & SU BLACKSBURG, VA 24061-0212	05
BUMP, CHARLES M. HAMPTON IUNIVERSITY CHEMISTRY DEPT HAMPTON, VA 23668	05	CATON, RANDALL 50 SHOE LANE CHRISTOPHER NEWPORT UNIV. NEWPORT NEWS, VA 23606	02
BUONCRISTIANI, A. MARTIN CHRISTOPHER NEWPORT UNIV 50 SHOE LANE NEWPORT NEWS, VA 23606	02	CHAMBERS, BARBARA F. 4220 DANDRIDGE TERRACE ALEXANDRIA, VA 22309-2807	02
BURKE, ARTHUR W. JR 7275 GLEN FOREST DR, SUITE 305 RICHMOND, VA 23226	09	CHATTIN, AMY C. 743 BRANDON AVE SW ROANOKE, VA 24015-5023	04
BURKHART, HAROLD E. FORESTRY DEPT VPI & SU BLACKSBURG, VA 24061-0324	01	CHENEY, RICHARD W. JR. 50 SHOE LANE CHRISTOPHER NEWPORT UNIV. NEWPORT NEWS, VA 23606	04
BUSH, LANCE NASA LANGLEY RESEARCH CENTER M.S. 200 HAMPTON, VA 23681-0001	13	CHEVALIER, ROBERT L. UNIVERSITY OF VIRGINIA - PEDIAT- RICS BOX 386 CHARLOTTESVILLE, VA 22908	09
BUSS, GLENN R. CSES DEPT VPI & SU BLACKSBURG, VA 24061	01	CHINNICI, JOSEPH P. BIOLOGY DEPT VIRGINIA COMMONWEALTH UNIV. RICHMOND, VA 23284	04

CHLEBOWSKI, JAN F. PO BOX 980614 RICHMOND, VA 23298-0614	04	CONWAY, CAROLYN M. BIOLOGY DEPT, BOX 842012 VIRGINIA COMMONWEALTH UNIV. RICHMOND, VA 23284-2012	04
CHRISTIE, GAIL E. PO BOX 980678 RICHMOND, VA 23298-0678	09	COOK, DESMOND C. PHYSICS DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529	02
CHU, SUNG-CHI COMPUTER SCIENCE DEPT, BOX 6933 RADFORD UNIVERSITY RADFORD, VA 24142	17	COOK, CHRISTOPHER JOHN 130 CASTLEGATE RD MACON, GA 31210-2151	05
CLARK, ALLEN K. CHEMISTRY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23508	05	CORLEY, KARL C. JR. PO BOX 980551 RICHMOND, VA 23298-0551	10
CLARK, KENNEDY H. 1500 E MAIN ST, SUITE 312 RICHMOND, VA 23219	19	COSTER, ABRAHAM A. 3541 W. BRADDOCK RD ALEXANDRIA, VA 22302	06
CLARKE, ALEX M. PO BOX 250 WARSAW, VA 22572	09	COTHRON, JULIA H. 9293 BUTTERNUT LANE MECHANICSVILLE, VA 23111	11
CLOUGH, STUART C. 125 FAIRWOOD DR RICHMOND, VA 23235	05	CRANFORD, JACK A. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	04
COLEMAN, PHILLIP H. PO BOX 980549 RICHMOND, VA 23298-0549	03	CRISSMAN, JUDITH A. CHEMISTRY DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401	05
COLLINS, PETER L. PO BOX 1344 FALLS CHURCH, VA 22041-0344	02	CRITTENDEN, JOHN B. 1876 AZALEA DR BLACKSBURG, VA 24060	
COMPTON, AMELIA D. PSYCHOLOGY DEPT UNIVERSITY OF RICHMOND RICHMOND, VA 23173	09	CROSBY, M. DAVID PO BOX 9081 PETERSBURG, VA 23806	01
COMPTON, DAVID R. PO BOX 980613 RICHMOND, VA 23298-0613	09	CROSS, GERALD H. 100 CHEATHAM VPI & SU BLACKSBURG, VA 24061-0321	04
CONNOR, THERESA E. ENVIRONMENTAL SCIENCE 4400 UNIVERSITY DR GEORGE MASON UNIVERSITY FAIRFAX, VA 22030	15	CROUSE, WALTER C. COLLEGE AVE, DEPT NATURAL SCI- ENCES CLINCH VALLEY COLLEGE WISE, VA 24293	05
CONWAY, ARTHUR F. BIOLOGY DEPT RANDOLPH-MACON COLLEGE ASHLAND, VA 23005	04	CURLEY, JAMES W. LONGWOOD COLLEGE FARMVILLE, VA 23901	02

REGULAR MEMBERS

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CURLING, KEVIN A. VIMS GLOUCESTER POINT, VA 23062	15	DEWEY, WILLIAM L. PO BOX 980568 RICHMOND, VA 23298-0568	09
DALEY, LAWRENCE R. COMPUTER SCIENCE DEPT HAMPTON UNIVERSITY HAMPTON, VA 23668	17	DEWOLFE, THOMAS E. BOX 133 HAMPDEN SYDNEY, VA 23943	10
DAMAJ, MOHAMAD IMAD PO BOX 980613 RICHMOND, VA 23298-0613		DOLS, SHEILAH 3743 JASON AVE ALEXANDRIA, VA 22302-1811	04
DARCANGELIS, RITA COMPUTER SCIENCE DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401-5358	17	DUBERG, JOHN E. 4 MUSEUM DRIVE NEWPORT NEWS, VA 23601	02
DAVENPORT, JAMES M. MATH SCIENCES DEPT VIRGINIA COMMONWEALTH UNIV. RICHMOND, VA 23284-2014	12	DUDAS, FRANK O. GEOLOGY DEPT 113A TECHNOLOGY BLDG NORFOLK, VA 23529	08
DAVIDSSON, JEFFREY J. PO BOX 81 WOODBERRY FOREST, VA 22989	02	DUDASH, MICHELE R. BOTANY DEPT UNIVERSITY OF MARYLAND COLLEGE PARK, MD 20742-5815	14
DAVIES, ROBIN LEE PO BOX 113 SWEET BRIAR, VA 24595	03	DUKAT, MALGORZATA PO BOX 980540 RICHMOND, VA 23298-0540	05
DAY, DONAL B. PHYSICS DEPT, MCCORMICK RD UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22901	02	DUNCAN, PERRY M. PSYCHOLOGY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23508	10
DE SA', RAFAEL O. BIOLOGY DEPT UNIVERSITY OF RICHMOND RICHMOND, VA 23173	04	DUPUY, DAVID L. PHYSICS DEPT VIRGINIA MILITARY INSTITUTE LEXINGTON, VA 24450	02
DEAVER, BASCOM S. JR. PHYSICS DEPT UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22904	02	DURRILL, PRESTON L. 1309 MADISON ST RADFORD, VA 24141	05
DEMENTI, PATRICIA L. 7519 OAKMONT DR RICHMOND, VA 23228	04	DUTTRY, PATRICIA PO BOX 285 PORT AYWOOD, VA 23138	15
DESJARDINS, STEVEN G. CHEMISTRY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450-0303	05	EBEL, RICHARD BIOCHEMISTRY & NUTRITION DEPT VPI & SU BLACKSBURG, VA 24061	09
DEVINCENTIS, JOSEPH G. 109 APPLEWHITE ST SMITHFIELD, VA 23430-5922	05	ECKERLIN, RALPH 8333 LITTLE RIVER TURNPIKE ANNANDALE, VA 22003	04

EDELMAN, LEONARD BIOLOGY DEPT LYNCHBURG COLLEGE LYNCHBURG, VA 24501-3199	03	FABIRKIEWICZ, ANN M. BOX 895 RANDOLPH-MACON WOMAN'S COL- LEGE LYNCHBURG, VA 24503	04
EDMONDS, WILLIAM J. 1610 KENNEDY AVE BLACKSBURG, VA 24060	01	FARRAH, JEANETTE MAIL STOP 248 NASA LANGLEY RESEARCH CENTER HAMPTON, VA 23681	13
EDWARDS, CAROLYN 1990 OLD HANOVER ROAD SANDSTON, VA 23150	09	FASHING, NORMAN J. BIOLOGY DEPT COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23187	04
EDWARDS, LESLIE E. 1990 OLD HANOVER ROAD SANDSTON, VA 23150	09	FICENEC, JOHN R. 1305 GLEN CORE LANE BLACKSBURG, VA 24060	02
ELGERT, KLAUS D. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061-0406	09	FINE, MICHAEL L. BOX 842012 VCU RICHMOND, VA 23284-2012	04
ELLER-MESHREKI, RHONDA M. COMPUTER SCIENCE DEPT RANDOLPH-MACON COLLEGE ASHLAND, VA 23005	17	FISHBACK, PAT D. 2401 HARTMAN STREET RICHMOND, VA 23223	11
ELLETT, VIRGINIA C. 56 LOCKE LANE RICHMOND, VA 23226	11	FISHER, CHET H. PSYCHOLOGY DEPT RADFORD UNIVERSITY RADFORD, VA 24142	10
ELMES, DAVID G. PSYCHOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	10	FLEMING, GARY P. VA DEPT OF CONSERVATION & REC 1500 E MAIN ST, SUITE 312 RICHMOND, VA 23219	19
ENGEL, GERALD L. 15 AVON CT BEACON FALLS, CT 06403-4923	02	FLINT, WARREN THE EASTERN SHORE INSTITUTE PO BOX 688 EXMORE, VA 23340	15
ERDLE, SANDRA Y. VA DEPT OF CONS & REC DIV NATURAL HERITAGE 1500 E MAIN ST SUITE 312 RICHMOND, VA 23219		FONTENOT, J.P. ANIMAL SCIENCE DEPT VPI & SU BLACKSBURG, VA 24061	05
ERGLE, WILLIAM D. 5941 CASTLE ROCK ROAD S.W. ROANOKE, VA 24018	02	FORBES, JAMES E. 5109 2A GOLDSBORO DR NEWPORT NEWS, VA 23605	04
EZEKWE, MICHAEL O. A9 RESEARCH STATION VIRGINIA STATE UNIVERSITY PO BOX 9122 PETERSBURG, VA 23806	01	FORD, GEORGE D. PO BOX 980551 RICHMOND, VA 23298-0551	09
EZELL, JAMES E. 725 WATCH HILL RD MIDLOTHIAN, VA 23113	04		

REGULAR MEMBERS

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FORMICA, JOSEPH V. PO BOX 980678 RICHMOND, VA 23298-0678	03	GATHRIGHT, THOMAS P.O. BOX 297 BATESVILLE, VA 22924-0297	08
FORNSEL, CLAIRE E. 1348 MEADOW LAKE RD VIRGINIA BEACH, VA 23454-2070	15	GELLER, E. SCOTT PSYCHOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	10
FOSTER, W. JOHN D. 7807 MILLCREEK DR RICHMOND, VA 23235	05	GETTINGER, RONALD D. BIOLOGY DEPT RANDOLPH-MACON WOMAN'S COL. 2500 RIVERMONT AVE LYNCHBURG, VA 24501	04
FOSTER, JOYCE G. USDA-ARS P.O. BOX 400, 1224 AIRPORT RD BEAVER, WV 25813-0400	14	GIESE, RONALD N. 214 JONES HALL COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23185	11
FOSTER, C. L. JR. 1203 AUGUSTA ST BLUEFIELD, WV 24701	02	GIOVANETTI, KEVIN PHYSICS DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	02
FRAME, KATHLEEN 13112 NESTLEWOOD CT HERNDON, VA 22071	04	GIPSON, TERRY A. BOX 9100 VIRGINIA STATE UNIVERSITY PETERSBURG, VA 23806	01
FRANCE, MARCIA B. CHEMISTRY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450-0303	05	GIURGIUTIU, VICTOR ESM DEPT VPI & SU BLACKSBURG, VA 24061-0219	06
FRANSON, RICHARD C. 11812 BRITAIN WAY RICHMOND, VA 23233	09	GLASSON, GEORGE E. DIV OF CURRICULUM & INSTR VPI & SU BLACKSBURG, VA 24061	11
FULLER, STEPHEN W. BIOLOGY DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401-5358	14	GLENNON, RICHARD A. MEDICINAL CHEMISTRY PO BOX 980540 RICHMOND, VA 23298-0540	09
GALLAHER, THOMAS N. CHEMISTRY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	05	GLOVER-FISCHER, DEBORAH P. 3901 GLOUCESTER RD ROCKY MOUNT, NC 27803-1112	05
GANDOUR, RICHARD D. CHEMISTRY DEPT, 107 DAVIDSON HALL VPI & SU BLACKSBURG, VA 24061-0212	05	GODORD, RENEE D. BIOLOGY DEPT HOLLINS COLLEGE ROANOKE, VA 24020	04
GARRETT, REGINALD H. BIOLOGY DEPT, GILMER HALL UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22903	04	GOEHRING, J. BROWN CHEMISTRY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450-0303	05
GARRISON, NORMAN E. BIOLOGY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807			

GOLLER, EDWIN J. RFD 5, BOX 21 LEXINGTON, VA 24450	05	GREEN, CALVIN C. 5135 NEW KENT HWY QUINTON, VA 23141-2519	11
GOOD, I. J. STATISTICS DEPT VPI & SU BLACKSBURG, VA 24061	12	GREENBERG, FLORINE A. PSYCHOLOGY DEPT NVCC, 8333 LITTLE RIVER TPKE ANNANDALE, VA 22003	10
GOODWIN, BRUCE K. GEOLOGY DEPT COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23187-8795	08	GREENE, VIRGINIA C. 540 E RIO RD CHARLOTTESVILLE, VA 22901	05
GOUGH, STEPHEN B. 1301 COLLEGE AVE BIOLOGY DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401	14	GREER, WILLIAM T. JR 1584 WESLEYAN DR NORFOLK, VA 23502	
GOURLEY, EUGENE V. BIOLOGY DEPT RADFORD UNIVERSITY RADFORD, VA 24142	04	GREGG, MICHAEL H. 503 LINKOUS CIRCLE BLACKSBURG, VA 24060	07
GRABAU, ELIZABETH PLANT PATHOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	01	GRUNDER, HERMANN A. 12000 JEFFERSON AVE NEWPORT NEWS, VA 23606	02
GRANGER, JILL NELSON 206 GUION - DEPT CHEMISTRY SWEET BRIAR COLLEGE SWEET BRIAR, VA 24595	05	GUSHEE, BEATRICE E. BOX 9675 HOLLINS COLLEGE ROANOKE, VA 24020-1675	05
GRANGER, ROBERT M. III CHEMISTRY DEPT VIRGINIA MILITARY INSTITUTE LEXINGTON, VA 24450	05	GUSTAFSON, GLEN C. GEOLOGY & GEOGRAPHY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	18
GRANT, GEORGE C. 179 DEVON PL NEWPORT NEWS, VA 23606	05	GWAZDAUSKAS, F. C. DAIRY SCIENCES DEPT VPI & SU BLACKSBURG, VA 24061	01
GRATZ, ROY F. 902 SYLVANIA AVE FREDERICKSBURG, VA 22401	05	HAAS, CAROLA A. 112 CHEATHAM HALL VPI & SU BLACKSBURG, VA 24061-0321	01
GRAU, HAROLD J. CNU DEPT OF BCES CHRISTOPHER NEWPORT UNIV NEWPORT NEWS, VA 23606	04	HAIRFIELD, ELIZABETH M. CHEMISTRY DEPT MARY BALDWIN COLLEGE STAUNTON, VA 24401	05
GRAY, F. HARRIET BOX 9616 HOLLINS COLLEGE ROANOKE, VA 24020		HALEY, CLARENCE D. JR. 2832 RIDGEVIEW DR AUGUSTA, GA 30909-9408	11
		HAN, KWANG S. 522 ELIZABETH LAKE DR HAMPTON, VA 23669-1724	02

REGULAR MEMBERS

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WASHINGTON, DC 20560			
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116 SCARBOROUGH PLACE		MATERIALS SCIENCE & ENG DEPT	
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		BLACKSBURG, VA 24061-0237	
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PO BOX 980614		DAIRY SCIENCE DEPT	
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		BLACKSBURG, VA 24061-0315	
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BIOLOGY DEPT			
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HARRISONBURG, VA 22807		P.O. BOX 726	
		SUFFOLK, VA 23439	
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12000 JEFFERSON AVE		103 CORBIN DR	
CEBAF		NEWPORT NEWS, VA 23606	
NEWPORT NEWS, VA 23606			
HARTLINE, FREDERICK F.	02	HIGGINS, THOMAS F. III	16
CHRISTOPHER NEWPORT UNIVERSITY		4712 HICKORY SIGN POST RD	
50 SHOE LANE		WILLIAMSBURG, VA 23185	
NEWPORT NEWS, VA 23606			
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CHEMISTRY DEPT		BIOLOGY DEPT	
VIRGINIA COMMONWEALTH UNIVER-		BRIDGEWATER COLLEGE	
SITY		BRIDGEWATER, VA 22812	
PO BOX 842006			
RICHMOND, VA 23284-2006		HILL, TREVOR B.	05
		228 LONGHILL RD	
HAYDEN, W. JOHN	14	WILLIAMSBURG, VA 23185	
BIOLOGY DEPT			
UNIVERSITY OF RICHMOND, VA 23173		HILU, KHIDIR W.	14
		BIOLOGY DEPT	
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HODGES, ROBERT LEE 1191 DUNCAN DR WILLIAMSBURG, VA 23185	01	HUNSUCKER, SALLY 47 FT WILLIAMS PKWY ALEXANDRIA, VA 22304	04
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HUDLICKY, MILOS 1005 HIGHLAND CIRCLE BLACKSBURG, VA 24060	05	JENSEN, DONALD R. STATISTICS DEPT VPI & SU BLACKSBURG, VA 24061	12
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KAIN, TETA 7083 CAFFEE CREEK LN GLOUCESTER, V 23061	19	KING, BRUCE L. BIOLOGY DEPT RANDOLPH-MACON COLLEGE ASHLAND, VA 23005	14

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LEEPER, CHARLES K. PO BOX 820 STEPHENS CITY, VA 22655	13	LISS, IVAN B. BOX 6941 RADFORD UNIVERSITY RADFORD, VA 24142	17
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LOESSER, KATHRYNE E. BIOLOGICAL SCIENCES DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401	09	MARONEY, SAMUEL P. JR. BIOLOGY DEPT - GILMER HALL UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22901	04
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LUND, ANNE C. 602 FOURTH AVE FARMVILLE, VA 23901	04	MARTIN, W. WALLACE BIOLOGY DEPT RANDOLPH-MACON COLLEGE ASHLAND, VA 23005	04
LUQUIRE, KAREN B. 3720 SPICEWOOD DR ANNANDALE, VA 22003-2249	04	MARTIN, JAMES E. MATHEMATICS DEPT, CNU 50 SHOE LANE NEWPORT NEWS, VA 23606	02
LUTZE, FREDERICK H. 1201 PATTON CT BLACKSBURG, VA 24060	13	MARTIN, R. BRUCE RT. 743 ARDWOOD 300 FOREST RIDGE RD EARLYVILLE, VA 22936-9219	05
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MACCORD, HOWARD A. SR 562 ROSSMORE RD RICHMOND, VA 23225	16	MAST, JOSEPH W. EASTERN MENNONITE UNIVERSITY HARRISONBURG, VA 22801	02
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MCCLUNG, J. KEITH BIOLOGY DEPT, PO BOX 6931 RADFORD, VA 24142	04	MESHEJIAN, WAYNE K. NATURAL SCIENCES DEPT LONGWOOD COLLEGE FARMVILLE, VA 23901	02
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MCLAUGHLIN, JOHN W. 2460 TILLET RD SW ROANOKE, VA 24015	11	MILLER, ORSON K. JR. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	14
MCNABB, F. M. ANNE 1002 EHEART ST BLACKSBURG, VA 24060	04	MILLS, RICHARD R. BIOLOGY DEPT BOX 2012, VCU RICHMOND, VA 23284	04
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MINTON, PAUL D. 2626 STRATFORD RD RICHMOND, VA 23225	12	MUNSON, ALBERT E. 5302 BEECHWOOD PT CT MIDLOTHIAN, VA 23112-2535	09
MITCHELL, JOSEPH C. BIOLOGY DEPT UNIVERSITY OF RICHMOND, VA 23173	04	MUSHRUSH, GEORGE W. CHEMISTRY DEPT 4400 UNIVERSITY DR GEORGE MASON UNIVERSITY FAIRFAX, VA 22030	05
MO, LUKE W. PHYSICS DEPT - ROBESON HALL VPI & SU BLACKSBURG, VA 24061	02	MYERS, WILLIAM H. 2007 ORANGEWOOD RD RICHMOND, VA 23235	05
MOLLICK, RONALD S. 50 SHOE LANE NEWPORT NEWS, VA 23606	04	NAGARKATTI, PRAKASH BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	09
MONCRIEF, NANCY MAMMALS DEPT VIRGINIA MUSEUM OF NATURAL HISTORY MARTINSVILLE, VA 24112	04	NAGARKATTI, MITZI DEPT BIOMED SCI & PATHOBIOLOG VA-MD COLL VET MED VPI & SU BLACKSBURG, VA 24061	09
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MOORE, ELIZABETH A. 4600 43RD PLACE, NW WASHINGTON, DC 20016		NASH, CAROLE L. 285 NEWMAN AVE HARRISONBURG, VA 22801	16
MOORE, DAVID J. 507 FIFTH ST RADFORD, VA 24141	15	NEEL, WILLARD WAYNE MECH ENGR DEPT VIRGINIA MILITARY INSTITUTE LEXINGTON, VA 24450	07
MOORES, BRIAN W. RANDOLPH-MACON COLLEGE, P.O. BOX 5005 ASHLAND, VA 23005-5505	15	NEUMANN, ALAN J. 880 MELROSE TERRACE NEWPORT NEWS, VA 23602-9300	14
MORELL, LARRY J. COMPUTER SCIENCE DEPT HAMPTON UNIVERSITY HAMPTON, VA 23668	17	NEVES, RICHARD J. FISHERIES AND WILDLIFE VPI & SU BLACKSBURG, VA 24061	15
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NIELSEN, ANNE W. RT 3, BOX 36 DAYTON, VA 22821		ORWOLL, ROBERT A. CHEMISTRY DEPT COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23185	05
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NWOKOGU, GODSON C. CHEMISTRY DEPT HAMPTON UNIVERSITY HAMPTON, VA 23668	05	PAGELS, JOHN F. PO BOX 842012 VCU RICHMOND, VA 23284-2012	04
O'DELL, DEBORAH A. BIOLOGY DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401	04	PAINTER, HARRY F. 8324 THE MIDWAY ANNANDALE, VA 22003	04
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		PENDLETON, WALLACE O. JR 2318 MCRAE RD RICHMOND, VA 23235	11

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PICKENS, JEFFREY PSYCHOLOGY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	10	REIFSNIDER, KENNETH L. 2127 WOODLAND HILLS DR BLACKSBURG, VA 24060	06
PINSCHMIDT, MARY W. 8 NELSON ST FREDERICKSBURG, VA 22405	09	REINDERS, THOMAS P. PO BOX 980581 RICHMOND, VA 23298-0581	09
PITTAS, PEGGY 719 SHERMAN DR LYNCHBURG, VA 24502	10	RENEAU, R. B. JR. 904 ELIZABETH DR BLACKSBURG, VA 24060	01
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PLEBAN, PATRICIA CHEMISTRY & BIOCHEMISTRY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23429	05	REPICI, DOMINIC J. 4105 MINSTRELL LANE FAIRFAX, VA 22033	02
POLAND, JAMES L. PO BOX 980551 RICHMOND, VA 23298-0551	09	REYNOLDS, MARION R. JR. STATISTICS DEPT VPI & SU BLACKSBURG, VA 24061	12
POWELL, W. ALLAN RFD 395 H DELTAVILLE, VA 23043	05	RICHARDS, ELIAS III MRS. 905 OLD TRENTS FERRY RD LYNCHBURG, VA 24503	04
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RABUNG, JOHN R. 501 CHAPMAN ST ASHLAND, VA 23005	17	RIES, HEIDI R. 2401 CORPREW AVE NORFOLK, VA 23504	06
RAMIREZ, DONALD E. MATH DEPT - KERCHOF HALL UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22903	02	RIESTER, REBECCA L. NVCC - LOUDOUN 1000 HFB HIGHWAY STERLING, VA 22170	
RAMSEY, GWYNN W. 1218 CHARLDON RD LYNCHBURG, VA 24501	14		

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RIVERS, WALTER GUY BIOLOGY DEPT LYNCHBURG COLLEGE LYNCHBURG, VA 24501	15	ROSENZWEIG, MICHAEL S. PO BOX 824 BLACKSBURG, VA 24063	04
ROANE, CURTIS W. PLANT PATH, PHYSIO, WEED SCI DEPT VPI & SU BLACKSBURG, VA 24061	01	ROUSE, GARRIE D. RT 1, BOX 25 AYLETT, VA 23009	14
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ROBACK, VINCENT ERIC 15H ANTIQUA BAY HAMPTON, VA 23666	13	RUDER, SUZANNE CHEMISTRY DEPT BOX 842006 RICHMOND, VA 23284-2006	05
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ROBERTS, JAMES N. 5621 RAPPAHANNOCK RD VIRGINIA BEACH, VA 23462	11	RUSSELL, DARCY L. BIOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	03
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ROGERS, GARY K. DEPT CEE VIRGINIA MILITARY INSTITUTE LEXINGTON, VA 22450	07	SABRE, MARA 772 TRIANGLE ST, APT 475 BLACKSBURG, VA 24060	04
ROONEY, HUGH 9032 CRAIGWOOD CIRCLE MECHANICSVILLE, VA 23111	14	SACKS, LAWRENCE J. 542 BURCHER RD NEWPORT NEWS, VA 23606	05
ROSE, ROBERT K. BIOLOGICAL SCIENCES DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529-0266	04	SATTLER, PAUL W. BIOLOGY/CHEMISTRY DEPT BOX 20000 LYNCHBURG, VA 24506-8001	04
ROSECRANSS, JOHN A. PO BOX 980613 RICHMOND, VA 23298-0613	09		

SAUDER, WILLIAM C. PHYSICS DEPT VIRGINIA MILITARY INSTITUTE LEXINGTON, VA 24450	02	SELBY, GREGORY PO BOX 7869 HAMPTON, VA 23666	
SAVITZKY, ALAN H. BIOLOGICAL SCIENCES DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529-0266	04	SEN, DILIP K. DEPT OF LIFE SCIENCES, BOX 9332 VIRGINIA STATE UNIVERSITY PETERSBURG, VA 23806	04
SCANLON, PATRICK F. FISHERIES & WILDLIFE DEPT VPI & SU BLACKSBURG, VA 24061-0321	15	SHANHOLTZ, VERNON O. AGRICULTURAL ENGR VPI & SU BLACKSBURG, VA 24061	01
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SCHREINER, SERGE 10405 OAK BAY CT RICHMOND, VA 23233	05	SHERWOOD, W. CULLEN GEOLOGY DEPT - MILLER HALL JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	08
SCHULMAN, ROBERT S. STATISTICS DEPT VPI & SU BLACKSBURG, VA 24061	12	SHIPES, BARBARA G. 101 CLAYTON DR YORKTOWN, VA 23693-5547	14
SCHWAB, DON 1411 PLANTERS DR SUFFOLK, VA 23434	04	SHOLLEY, MILTON M. PO BOX 980709 RICHMOND, VA 23298-0709	09
SCRABLE, HEIDI DEPT OF NEUROSCIENCE, BOX 5148, MR4 UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22908	09	SIEGEL, PAUL B. POULTRY SCIENCE DEPT VPI & SU BLACKSBURG, VA 24061	01
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SEIDENBERG, ARTHUR J. BIOLOGY DEPT, BOX 2019 VIRGINIA COMMONWEALTH UNIVER- SITY RICHMOND, VA 23284-2019	04	SIMURDA, MARYANNE C. BIOLOGY DEPT, 304 PARMLY HALL WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	09

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SMITH, CAROLYN J. 4706 CHESTNUT FORK RD GLOUCESTER, VA 23061	04	SPENCER, JACQUELINE 42 LOCUST AVE HAMPTON, VA 23661	04
SMITH, EMMA B. 3400 NORTH STREET ETTRICK, VA 23803-1632		SPENCER, TURNER M. BIOLOGY DEPT THOMAS NELSON COMMUNITY COL- LEGE HAMPTON, VA 23366	11
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SOINE, WILLIAM H. PO BOX 980540 RICHMOND, VA 23298-0540	09	STARNES, WILLIAM H. CHEMISTRY DEPT COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23187-8795	05
SOKOLOWSKI, STEVEN W. 1267-A W. 27TH ST NORFOLK, VA 23508	03	STAUNTON, NICKY 8815 FORT DR MANASSAS, VA 22110	14
SPEARMAN, M. LEROY M.S. 406 NASA, LANGLEY RESEARCH CENTER HAMPTON, VA 23665	13	STEEHLER, JACK CHEMISTRY DEPT ROANOKE COLLEGE SALEM, VA 24153	05

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|--|----|--|----|
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CHEMISTRY DEPT
ROANOKE COLLEGE
SALEM, VA 24153 | 05 | SUCHECK, TREASURE J.
709 IVY ST APT 4
WAYNESBORO, VA 22980-3784 | |
| STENGER, KRISTA FISCHER
BIOLOGY DEPT
UNIVERSITY OF RICHMOND
RICHMOND, VA 23173 | 09 | SULLIVAN, ANN M.
P.O. BOX 85622, DOWNTOWN CAMPUS
RICHMOND, VA 23285-5622 | 05 |
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1115 MORNINGSTAR LANE
FAIRMONT, WV 26554 | 14 | SWANK, SARAH
BIOLOGY DEPT
BRIDGEWATER COLLEGE
BRIDGEWATER, VA 22812 | 04 |
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615 PRESTON PLACE
CHARLOTTESVILLE, VA 22903 | 08 | SWARTWOOD, SUZANNE C.
44959 BOURNE TER
ASHBURN, VA 22011-2763 | 03 |
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2 HARDING ST
ROCHESTER, NH 03867-3721 | 05 | SWEITZER, EDWARD M.
PO BOX 1187
SKIPPACK, PA 19474-1187 | 04 |
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4413 WOODS EDGE CT
CHANTILLY, VA 22021-2409 | |
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WOODBERRY FOREST SCHOOL
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WOODBERRY FOREST, VA 22989 | 11 | TEATES, THOMAS
305 WAR MEMORIAL HALL
VPI & SU
BLACKSBURG, VA 24061-0313 | |
| STRAUSS, RICHARD T.
1308 WESTMORELAND AVE
NORFOLK, VA 23508 | 11 | TELIONIS, D. P.
ENG. SCIENCE & MECH.
VPI & SU
BLACKSBURG, VA 24061 | 13 |
| STRONG, SUSAN M. B.
RT. 3, BOX 41
FERRUM, VA 24088 | 09 | TEMPLE, DOYLE
PHYSICS DEPT
HAMPTON UNIVERSITY
HAMPTON, VA 23668 | 2 |
| STRUTT, MICHAEL
P.O. BOX 419
CORP FOR JEFFERSON'S POPLAR FOR-
EST
FOREST, VA 24551 | 16 | TERMAN, C. RICHARD
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COLLEGE OF WILLIAM & MARY
WILLIAMSBURG, VA 23185 | 04 |
| STUCK, KENNETH E.
304 SMOKEY TRAIL
NEWPORT NEWS, VA 23602 | 16 | TERNER, JAMES
P.O. BOX 842006
VIRGINIA COMMONWEALTH UNIVER-
SITY
RICHMOND, VA 23284-2006 | 05 |
| STUMP, B. L.
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TINNELL, WAYNE H. NATURAL SCIENCE DEPT LONGWOOD COLLEGE FARMVILLE, VA 23901	03	VAN ENGEL, WILLARD A. VIMS GLOUCESTER POINT, VA 23062	04
TISSUE, BRIAN M. CHEMISTRY DEPT VPI & SU BLACKSBURG, VA 24061-0212	05	VAN ALSTINE, NANCY E. 6209 CLOVER LANE RICHMOND, VA 23228	14
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TORZILLI, ALBERT P. 12510 KINGS LAKE DRIVE RESTON, VA 22091		WAKEHAM, HELMUT R. 8905 NORWICK RD RICHMOND, VA 23229	05
TROUT, W. E. III 35 TOWANA RD RICHMOND, VA 23226	04	WALKER, RICHARD D. 701 BROCE DR NW BLACKSBURG, VA 24060	07
TROWER, W. PETER PHYSICS DEPT VPI & SU BLACKSBURG, VA 24061	02	WALLER, DEBORAH ANN BIOLOGY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23429	04
TURNER, GAIL C. BIOLOGY DEPT, BOX 842012 VIRGINIA COMMONWEALTH UNIVER- SITY RICHMOND, VA 23284-2012	04	WALSH, SCOTT W. PO BOX 980034 RICHMOND, VA 23298-0034	09
TURPIN, PAMELA 1120 WOODCREST DR BEDFORD, VA 24523		WARD, LAUCK W. VIRGINIA MUSEUM OF NATURAL HIS- TORY 1001 DOUGLAS AVE MARTINSVILLE, VA 24112	08
UFFELMAN, ERICH S. CHEMISTRY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450-0303	05	WARD, SARAH JANE 518 FAIRFAX AVE NORFOLK, VA 23507-2110	10
		WARE, STEWART A. BIOLOGY DEPT COLLEGE OF WILLIAM & MARY WILLIAMSBURG, VA 23185	14

WATTS, CHESTER F. GEOLOGY DEPT RADFORD UNIVERSITY RADFORD, VA 24142	08	WHITE, CATHERINE W. 4108 CRESTWOOD RD RICHMOND, VA 23227	09
WEBB, KENNETH L. SCHOOL OF MARINE SCIENCE COLLEGE OF WILLIAM & MARY GLOUCESTER POINT, VA 23062	04	WHITE, LARRY H. CHEMISTRY DEPT HARRISONBURG HIGH SCHOOL HARRISONBURG, VA 22801	09
WEEMS, ROBERT E. MAIL STOP 928 US GEOLOGICAL SURVEY RESTON, VA 22092	08	WHITEMAN, LESLIE YOLANDA 9801 ALDERSMEAD PL RICHMOND, VA 23236-4649	03
WEILAND, ELIZABETH M. 2004 BURKS ST PETERSBURG, VA 23805	04	WHITNEY, DONALD A. PHYSICS DEPT HAMPTON UNIVERSITY HAMPTON, VA 23668	02
WEISS, ARMAND B. 6516 TRUMAN LANE FALLS CHURCH, VA 22043	02	WHITTEMORE, ROBERT E. 208 MARK DR GRAY, TN 37615	08
WEISS, T. EDWARD JR. BIOLOGY DEPT CHRISTOPHER NEWPORT UNIVERSITY NEWPORT NEWS, VA 23606-2998	14	WIELAND, WERNER BIOLOGICAL SCIENCES DEPT MARY WASHINGTON COLLEGE FREDERICKSBURG, VA 22401-5358	04
WELCH, SANDRA P. PO BOX 980613 RICHMOND, VA 23298-0613	09	WIGGINS, BRUCE A. BIOLOGY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	03
WELCH, CHRISTOPHER S. ROUTE 3, BOX 1076 GLOUCESTER, VA 23061	02	WIGGINS, HAROLD JAMES 13 LAVELLE DR FREDERICKSBURG, VA 22407	15
WELLER, MARY H. ROUTE 1, BOX 35C CHARLOTTESVILLE, VA 22903	11	WIGGLESWORTH, HAYWOOD A. 2420 POATES DR RICHMOND, VA 23228-3042	
WELSTEAD, WILLIAM J. 10471 JORDAN PARKWAY HOPEWELL, VA 23860	05	WIGHTMAN, JAMES P. CHEMISTRY DEPT BLACKSBURG, VA 24061	05
WEST, TRAYCIE L. DEPT OF ENV'T QUALITY 5636 SOUTHERN BLVD VIRGINIA BEACH, VA 23462	15	WILDEUS, STEPHAN A. BOX 9383 VIRGINIA STATE UNIVERSITY PETERSBURG, VA 23806	01
WHEELER, ALFRED G. PA DEPT OF AGRICULTURE 2301 NORTH CAMERON ST HARRISBURG, PA 17110-9408	01	WILEY, JENNY BOX 980613 RICHMOND, VA 23298-0613	09
WHISONANT, ROBERT C. GEOLOGY DEPT RADFORD UNIVERSITY RADFORD, VA 24141	08	WILKES, GERALD 3315 RED HILL RD NORTH GARDEN, VA 22959	08

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WILLIAMS, BILL PO BOX 8783 WILLIAMSBURG, VA 23187-8783	11	WINTERS, DAVID LEE CHEMISTRY DEPT TIDEWATER COMMUNITY COLLEGE 1700 COLLEGE CRESCENT VIRGINIA BEACH, VA 23456	05
WILLIAMS, R. L. CHEMISTRY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529	05	WISE, JAMES A. BIOLOGICAL SCIENCE DEPT HAMPTON UNIVERSITY HAMPTON, VA 23668	04
WILLIAMS, PATRICIA B. PHARMACOLOGY DEPT, PO BOX 1980 E. VIRGINIA MEDICAL SCHOOL NORFOLK, VA 23501	09	WISHNER, LAWRENCE A. 1645 HEATHERSTONE DR FREDERICKSBURG, VA 22407	05
WILLIAMS, HOLLY B. 5105 S 10TH ST # 2 ARLINGTON, VA 22204	04	WITSCHHEY, WALTER R. T. SCIENCE MUSEUM OF VIRGINIA 2500 W BROAD ST RICHMOND, VA 23220	16
WILLIS, ROBERT A. JR COMPUTER SCIENCE DEPT HAMPTON UNIVERSITY HAMPTON, VA 23668	02	WITTKOFSKI, J. MARK 7506 SWEETBRIAR RD RICHMOND, VA 23229	16
WILLIS, LLOYD L. RT. 6, BOX 1-A PIEDMONT VIRGINIA COMMUNITY COLLEGE CHARLOTTESVILLE, VA 22901	14	WOLFE, LUKE G. PO BOX 980539 RICHMOND, VA 23298-0539	12
WILSDORF, H.G.F. MATERIALS SCIENCE DEPT-THORN- TON HALL UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22903	07	WOLFE, JAMES F. BURRUSS - 201 VPI & SU BLACKSBURG, VA 24061	05
WILSON, ERNEST BOX 64 VIRGINIA STATE COLLEGE PETERSBURG, VA 23803	14	WONG, ERIC A. ANIMAL SCIENCE DEPT VPI & SU BLACKSBURG, VA 24061-0306	01
WINGFIELD, E. BURWELL BIOLOGY DEPT VIRGINIA MILITARY INSTITUTE LEXINGTON, VA 24450	04	WOODS, THOMASENA H. SCIENCE SUPERVISOR 12465 WARWICK BLVD NEWPORT NEWS, VA 23606	11
WINSTEAD, JANET BIOLOGY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	14	WOOLCOTT, WILLIAM S. BIOLOGY DEPT UNIVERSITY OF RICHMOND, VA 23173	04
WINSTON, JUDITH E. VIRGINIA MUSEUM OF NATURAL HIS- TORY 1001 DOUGLAS AVE MARTINSVILLE, VA 24112	04	WOROBEC, R.B. 1000 CROTON DR ALEXANDRIA, VA 22308	03
		WRIGHT, ROBERT A. S. 8337 DEVILS DEN LANE MECHANICSVILLE, VA 23111	14

WRIGHT, THEODORE R. F. BIOLOGY DEPT UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22903	04
WU, DAXIN PO BOX 2284 FERRUM COLLEGE FERRUM, VA 24088	02
YANNI, JOHN 2821 DONNYBROOK DR BURLESON, TX 76028-8934	09
YOUSTEN, ALLEN A. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	03
ZAHN, MARTIN 202 OLD LAKESIDE DR YORKTOWN, VA 23692	04
ZAPOTOCZNY, JOSEPH E. 204 CHANDELLE BLVD WAYNESBORO, VA 22980	11

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ADAMS, IRMA B 1234 WESTMINSTER AVE RICHMOND, VA 23227	09	BOND, JASON E. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	19
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ANONICK, KRISTEN 13719 QUEENSGATE RD MIDLOTHIAN, VA 23113	11	BOOMER, MARCIA 5528 WHIRLAWAY RD VIRGINIA BEACH, VA 23462	15
ATKINS, ROBERT W. PHYSICS DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	02	BORRERO, LUZ M. DEPT FISHERIES AND WILDLIFE SCI VPI & SU BLACKSBURG, VA 24060-0321	15
AURENTZ, CAREY A. 119 ELM LAKE WAY YORKTOWN, VA 23693	04	BREEDEN, TIMOTHY M. BOX 980678 RICHMOND, VA 23298-0678	09
AVILA, JUANITA V. 8509 CAVALRY LANE MANASSAS, VA 22110-4812	17	BROOKS, ANTONIO C. 11132 MOUNTHOPE CHURCHRD DOSWELL, VA 23047	04
BEALE, MARK L. 617 TAPAWINGO ROAD SW VIENNA, VA 22180	04	BROWN, LAVERNE L. 1304 MIDDLEBERRY DR RICHMND, VA 23231	05
BECRAFT, SHUNIA M. 4500 DELCO RD VIRGINIA BEACH, VA 23455	08	BROWN, DAVID ALAN 610 TRIMBLE SHOALS BLVD SUITE 302B NEWPORT NEWS, VA 23606	15
BEELER, LINDA 3880 SHERMAN OAKS AVE VIRGINIA BEACH, VA 23456	10	BROWN, ARUNSRI C. BIOLOGY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529	04
BELLOWS, A. SCOTT 8173 LEE DAVIS RD MECHANICSVILLE, VA 23111-7002	04	BROWN, DAVID A. CS BOX 3726 WILLIAMSBURG, VA 23186	16
BENNETT, BARBARA BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061-0406	04	BURT, JENNIFER L. MS 152 NASA, LANGLEY RESEARCH CENTER HAMPTON, VA 23681-0001	13
BERN, CARLETON R. 4 LADUE CIR PITTSFORD, NY 14534-3672	15	CALFEE, KAREN L. 6441 PENRITH DR MECHANICSVILLE, VA 23111	04
BERNSTEIN, MARISSA A. PO BOX 980613 RICHMOND, VA 23298-0613	09	CAMPAGNE, JEAN-MICHEL 1312 BLUE JAY LANE RICHMOND, VA 23229	05
BHANDARI, RASHMI JMU BOX 5682 HARRISONBURG, VA 22807	10		

CARDULLO, CATHERINE BIOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	09	COX, JAMES D. 798 CINNAMINSON ST PHILADELPHIA, PA 19128-1512	01
CASTEVENS, CHARLES M. PHYSICS DEPT, BOX 2000 VIRGINIA COMMONWEALTH UNIVER- SITY RICHMOND, VA 23284-2000	02	CREASY, KIM PO BOX 980613 RICHMOND, VA 23298-0613	09
CHARBONEAU, AUBRI L. 10713 BOYDTON PLANK RD DINWIDDIE, VA 23841	09	CROZIER, J. BROOKS PPWS VPI & SU BLACKSBURG, VA 24060	01
CHEAVENS, JENNIFER 3100 W 22ND ST APT C4 LAWRENCE, KS 66047-3605	10	CUBITT, CHRISTINE C. 6109 CHARLECOTE CIRCLE VIRGINIA BEACH, VA 23464	09
CHEVAILLIER, CANDICE 1600 PATRICK HENRY DR APT # 239 BLACKSBURG, VA 24060		CURTIS, ANTHONY D. BIOLOGY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529	04
CHU, DAN-MY T. BOX 980678 RICHMOND, VA 23298-0678	03	DAMALAS, ANDY P. 5157 hARGROVE BLVD VIRGINIA BEACH, VA 23464	15
COGGSHALL, KELLY A. 1800 JEFFERSON PARK AVE APT 409 CHARLOTTESVILLE, VA 22903	05	DANDOEY, JEREMIAH R. 1321 BOTETOURT GARDENS NORFOLK, VA 23517	16
CONNER, JOY 820 GUILFORD CT VIRGINIA BEACH, VA 23464-3016	10	DATILLO, KEITHA M. 10431 STALLWORTH COURT FAIRFAX, VA 22032	15
CONORS, FANNY PO BOX 216 NEW MARKET, MD 21774-0216	04	DAVIS, ELLEN 37 SHIRLEY RD NEWPORT NEWS, VA 23601-3935	03
CONRAD, MARGARET K. 101 W 67TH ST APT 47H NEW YORK, NY 10023-5952	10	DAVIS'LIBRE, MARY CAROLE 2101B ROCKY POINT RUN CHESAPEAKE, VA 23320	10
COOK, STACIE BOX 980613 RICHMOND, VA 23298-0613	09	DAWSON, SHELLA E. PO BOX 40 AMHERST, VA 24521-0040	01
COUCH, CHARLENE R. 610 MONTOUR DR RICHMOND, VA 23236	04	DEWEY, MICHAEL BOXC 980613 RICHMOND, VA 23298-0613	09
COULLING, PHILIP CB # 3280 COKE HALL UNC-CH CHAPEL HILL, NC 27599-3280	14	DILLON, GREGORY K. 558 N 5TH ST APT 4 LARAMIE, WY 82070	18
COVINGTON, ROBERT M. 2290 S VINE APT 726 DENVER, CO 80210	04	DOLAN, JAMES 106 CALDRONEY DR NEWPORT NEWS, VA 23602	04

STUDENT MEMBERS

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DOUGLAS, RUTH A. 108 WILD FLOWER DR CHARLOTTESVILLE, VA 22911-8543	11	GAUDET, MICHELLE MATERIALS SCIENCE BLDG UNIVERSITY OF VIRGINIA CHARLOTTESVILLE, VA 22903	06
DREW, MICHAEL 47 LAWRENCIA DR LAWRENCEVILLE, NJ 08648	10	GAYLORD, CLARK PO BOX 603 BLACKSBURG, VA 24063-0603	12
DUNAWAY, MARK 302 BROADWAY AVE GLEN BURNIE, MD 21061	19	GIBSON, KATHLEEN M. 4170 WOODLAKE CT VIRGINIA BEACH, VA 23452-1120	10
DVORAK-GRANTZ, ANDREA L. BIOLOGY DEPT, DERRING HALL VPI & SU BLACKSBURG, VA 24061-0406	04	GILMORE, RICHARD G. III 520 JAMESTOWN RD WILLIAMSBURG, VA 23185	16
EBERLY, KRISTEN E. DEPT OF ENV SCIENCE 7 GEOLOGY BOX MWC 2069 1701 COLLEGE AVE FREDERICKSBURG, VA 22401-4666	15	GOLDIN, KEITH BOX 980613 RICHMOND, VA 23298-0613	09
EDWARDS, RHONDA RT 5, BOX 739 HILLSVILLE, VA 24343	14	GRASSO, MICHAEL G. 819 OLIVE DR NEWPORT NEWS, VA 23601	10
ELLIS, E. DARREN 2900 RENNOC RD KNOXVILLE, TN 37918-1813	02	GRIMSHAW, AMY H. 122139 WOLF VALLEY DR CLIFTON, VA 22024	10
EVANS, KIMMARA 27 BEACONS WAY APT B HAMPTON, VA 23669	15	HALECKI, JANICE 9629 HAMMETT PKWY NORFOLK, VA 23503	10
FORNSHELL, BEN J. 6911 QUANDER RD ALEXANDRIA, VA 22307	17	HANSEN, RONDA K. 3914 POWHATAHN AVE # A NORFOLK, VA 23508-2251	09
FOUST, CHRISTOPHER J. 12345 GAYTON BLUFFS LANE RICHMOND, VA 23233	04	HARDEE, RICHARD W. 904 SAINT DAVIDS PLACE VIRGINIA BEACH, VA 23464	10
FRITZ, WAYNE 26 WEBSTER ST WESTMINSTER, MD 21157	04	HARRIS, MICHAEL S. GEOLOGY DEPT UNIVERSITY OF DELAWARE NEWARK, DE 19716-2544	08
FUHRMANN, HENRI 8 BROOKFIELD DR HAMPTON, VA 23666	13	HARRIS, SANDRA 4075-3D MINERAL SPRING LN GLEN ALLEN, VA 23060	04
FUJIMORI, KEN BOX 980613 RICHMOND, VA 23298-0613	09	HAYES, BRYAN 1301 LONGWOOD DR # 1 NORFOLK, VA 23508	10
GAINES, OLA M. 3700 MORGAN TRAIL DR CHESTERFIELD, VA 23832	01	HECKMAN, JOHN R. 2119 DERRING HALL VPI & SU BLACKSBURG, VA 24061	15

HERMAN, JULIE PO BOX 598 GLOUCESTER POINT, VA 23062	08	KAMATH, ARATI BIOMEDICAL SCIENCES DEPT COLLEGE OF VET MEDICINE VPI & SU BLACKSBURG, VA 24061	09
HERMAN, STEPHEN W. 4801-A COLLEY AVE NORFOLK, VA 23508	08	KERR, LAURIE 2952 ADAM KEELING RD VIRGINIA BEACH, VA 23454	10
HILL, STEWART A. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061	04	KHET, MYAT MYAT 101 W PEMBROKE AVE # 12 HAMPTON, VA 23669	02
HINSHAW, ROSANNE 1523 OAK KNOLL LN VIRGINIA BEACH, VA 23464	08	KIFLE, YESHIRAREG 157 HICKORY DR SW PAPASKALA, OH 43062-9105	03
HITE, VALERIE E. 1407 WESTWOOD AVE RICHMOND, VA 23227	09	KIMARO, ANAEL CHEMISTRY DEPT HAMPTON UNIVERSITY HAMPTON, VA 23668	05
HOAGLAND, RACHEL L. 3779 KINGS GRANT RD VIRGINIA BEACH, VA 23452	10	KITE, SHERRY R. RT 1, BOX 36 ELKTON, VA 22827	05
HOBBS, MARIA 1049 TOWANDA DR VIRGINIA BEACH, VA 23464-3420	10	KNICK, EMILY K. CHEMISTRY DEPT JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	05
HOLMQUIST, RICHARD K. 1474 LAFAYETTE RD GLOUCESTER POINT, VA 23062	04	KOHLER, JENNIFER T. 740 LITTLE CONESTOGA RD GLENMOORE, PA 19343	04
HOOPER, H. BROOKS CHEMISTRY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	05	KOPERA, PAUL G. R. 3905 HILLRIDGE CT VIRGINIA BEACH, VA 23452-2120	15
HYER, KENNETH E. 38H MEADOWCREST RD RICHMOND, VA 23233-3106	15	KUHAR, THOMAS P. ENTOMOLOGY DEPT VPI & SU BLACKSBURG, VA 24061-0319	01
IMPELLITTERI, CHRIS 610 RHODE ISLAND AVE APT. B NORFOLK, VA 23508	08	LAKE, KRISTY D. 2712 E BROAD ST # 2 RICHMOND, VA 23223	09
JAPPEE, SHRUTI BOX 980694 RICHMOND, VA 23298-0694	07	LARGEN, KIM D.B. 16400 GINGERWOOD CT GAINESVILLE, VA 22065	15
JOHNSON, EMILY 225 WEST TAZEWEEL WAY WILLIAMSBURG, VA 23185	16	LAWRENCE, JAMES 4515 HIGH ST W PORTSMOUTH, VA 23703-4403	
JONES, GREGORY V. RR 1 BOX 244A CHARLOTTESVILLE, VA 22903-9737	08		

STUDENT MEMBERS

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LAWWILL, KENNETH S. 13319 SCIBILIA CT FAIRFAX, VA 22033-1413		LOXTERMAN, JANET L. 6325 CROSSWINDS DR CLOVER, SC 29710-7527	04
LAYMAN, HOLLY M. CHEMISTRY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	05	MACERA, C. ANTHONY 1444 MAHARIS RD VIRGINIA BEACH, VA 23455	10
LEBEL, LUC G. FORESTRY DEPT VPI & SU BLACKSBURG, VA 24061-0324	01	MADDOX, KRISTY L. 3310 WINSTON BLVD APT 204 WILMINGTON, NC 28403-2644	
LEWIS, TIMOTHY A. BOX 980678 RICHMOND, VA 23298-0678	09	MARSCHEIDER, MARIA 137 SHIP SHOAL WAY VIRGINIA BEACH, VA 23451	10
LEWIS, KRISTI L. 104 NORTH HARVIE APT 1 RICHMOND, VA 23220	09	MASON, DAVID BOX 980613 RICHMOND, VA 23298-0613	09
LIANG, HONGPING BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24060	04	MATEJA, GEORGE 1028 ROCKBRIDGE AVE # 120 NORFOLK, VA 23508	15
LINDHOLM, DEAN INSTITUTE OF ECOLOGY UNIVERSITY OF GEORGIA ATHENS, GA 30602		MATKINS, JUANITA JO 624 YANCEYVILLE RD LOUISA, VA 23093	11
LITHERLAND, STEVEN 1404 SYDNEY CT CHESAPEAKE, VA 23320	10	MAYS, JAMES E. 9506 SUNDIAL CT RICHMOND, VA 23294-5509	12
LIU, DANHUI PO BOX 980694 RICHMOND, VA 23298-0694	07	MCALLISTER, SEAN BOX 980613 RICHMOND, VA 23298-0613	09
LIVELY, JONATHAN M. 4009 LATHAM DR HAYMARKET, VA 22069	04	MCCAULEY, ENZA J. 2518 RETRIECERS RIDGE RD RICHMOND, VA 23233	11
LLEWELLYN, BARBARA E. BOX 980033 RICHMOND, VA 23298-0033	09	MCCLISH, DANA B. 901 GREENWAY CT # 8 NORFOLK, VA 23507	08
LLEWELLYN, G. CRAIG BOX 980613 RICHMOND, VA 23298-0613	09	MCDONALD, LAURA P. RR 1 BOX 94-A PEMBROKE, VA 24136-9719	04
LONDON, WENDY B. BOX 980032 RICHMOND, VA 23298-0032	12	MCKAY, SAMUEL L. III 1001-A CAMBRIDGE CRES NORFOLK, VA 23508	08
LOUQUE, ROBERT W. 100 OLD LONG BRANCH RD CULLOWHEE, NC 28723-9601	04	MCKENZIE, WOODROW L. 408 PIEDMONT ST BLACKSBURG, VA 24060	11
		MCTAMMANY, MATTHEW E. 2931 WEATHERLY CT BLACKSBURG, VA 24060	04

MCTHENIA, ANDREW W. ROUTE 2, BOX 201 LEXINGTON, VA 24450	08	MULLINS, DAVID W. 2119 DERRING HALL BIOLOGY DEPT VIRGINIA TECH BLACKSBURG, VA 24061-0406	03
MEHTA, ROOMA M. PO BOX 842006 RICHMOND, VA 23284-2006	05	NASSIF, LANA 750 TALL OAKS DR APT # 13600A BLACKSBURG, VA 24060	03
MENG, UYN BOX 980613 RICHMOND, VA 23298-0613	09	NEEL, ROBERT W. RT 2, BOX 12A LEXINGTON, VA 24450	10
MICHAEL, PAUL 409 HUNT CLUB RD APT 36F BLACKSBURG, VA 24060	10	NELMS, CHRISTINE E. PO BOX 1713 VIRGINIA BEACH, VA 23451-9713	10
MILLER, LINDA E. 708 SIR WALTER CIRCLE VIRGINIA BEACH, VA 23452	10	NELSON, GLENORA 5840 CAMERION RUN TER APT 1114 ALEXANDRIA, VA 22303-1811	10
MOON, YOUNG C. 821 ORCHARD ST APT 7 BLACKSBURG, VA 24060-7109	12	NNAMANI, IJEOMA N. 5785 TIVOLI CIR APT 109 RICHMOND, VA 23227-2755	05
MOORE, KERI H. 10817 N BANK RD RICHMOND, VA 23233	08	NOONAN, GLYNIS M. 716 S DELAWARE AVE TAMPA, FL 33606-2913	10
MORGAN, DONALD R. 5801 CHANNING RD SPRINGFIELD, VA 22150	04	NORRIS, MARIAN 425 NEW HAMPSHIRE AVE NORFOLK, VA 23508	04
MORLINO, SUSAN E. 6812 MILL CREEK DR ZUNI, VA 23898	04	NYANTAKYI, PAUL S. 6301 STEVENSON AVE # 501 ALEXANDRIA, VA 22304	06
MORRIS, GARY Z. 1701 HARMON ST APT 202 NORFOLK, VA 23518	04	OH, SEI JIN 5504 MONROE PL 252-B NORFOLK, VA 23508	10
MORRIS, EDGAR 6806 PLANTATION FOREST DR SPOTSYLVANIA, VA 22553-7785	04	OLEJNICZAK, JULIE ANN 3000 S RANDOLPH ST APT 246 ARLINGTON, VA 22206-2250	03
MOSCA III, THOMAS C. 6977 ARK RD GLOUCESTER, VA 23061	05	OLSON, JOHN M. BOX 980678 RICHMOND, VA 23298-0678	04
MOURE, M. CARMEN 3935 WATERVILLE CT # 12 RICHMOND, VA 23233	09	OMASTER, JENNIFER ROUTE 7, BOX 8494 GLOUCESTER, VA 23061	05
MUKHERJEE, NILAY BOX 980694 RICHMOND, VA 23298-0694		ORZECZOWSKA, GRAZYNA E. CHEMISTRY & BIOCHEMISTRY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529	

STUDENT MEMBERS

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OVERACKER, JOHN 3350 KENWICK TRAIL, SW ROANOKE, VA 24018	05	RABUNG, ADAM 501 CHAPMAN ST ASHLAND, VA 23005	17
OWUSU-SAKYI, JOSEPHINE 2643 HYDRAULIC RD APT D CHARLOTTESVILLE, VA 22901	09	RAFI, ASIMAH Q. 2113 DERRING HALL VPI & SU BLACKSBURG, VA 24061	09
PAIBIR, SHEELA G. PO BOX 980540 RICHMOND, VA 23298-0540	09	RHILE, MARK J. 1324 WILLOW GLEN CIR APT 150 FORT WORTH, TX 76134-4927	04
PARK, GYUNG-SOO BIOLOGICAL SCIENCES DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529	04	RICE, ANDREW BIOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	09
PATCH, HARLAND M. PO BOX 842012 RICHMOND, VA 23284-2012	04	RIDER RAAMSES P. 102 JEFFREIS DR APT H RADFORD, VA 24141	10
PATRICK, GRAHAM BOX 980613 RICHMOND, VA 23298-0613	09	RINEHART, SHERRY C. 6916 COLUMBIA DR ALEXANDRIA, VA 22307-1605	04
PHILLIPS, KATHLEEN E. BOX 980613 RICHMOND, VA 23298-0613	09	RISSER, MATTHEW 5175 CYPRESS POINT CIRCLE VIRGINIA BEACH, VA 23455	10
PHILLIPS, RYAN C/O TREASURE SUCHECK 709 IVY ST APT 4 WAYNESBORO, VA 22980-3784		ROHRER, WENDY 308 WASHINGTON ST SE BLACKSBURG, VA 24060-4840	14
PONTIER, NANCY K. 3731 LUDGATE DR CHESAPEAKE, VA 23321	08	RUDMIN, JOSEPH D. 224 STRIBLING AVE CHARLOTTESVILLE, VA 22903	
POTTS, ALICE A. 7716 MILLCREEK DR RICHMOND, VA 23235	04	RUSSELL, DANA 500 N EMMET ST H-6 CHARLOTTESVILLE, VA 22903	06
PRIDEAUX, J. PO BOX 980551 RICHMOND, VA 23298-0551	09	SEABORN, DAVID W. BIOLOGICAL SCIENCES DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529-0266	04
PULLEY, JASON E. 9046 PEANUT DR WINDSOR, VA 23487	04	SELVAAG, TRACY L. 3417 CHESAPEAKE AVE HAMPTON, VA 23661-3514	14
PURDY, MICHAEL D. 241 WAYT ST STAUNTON, VA 24401	02	SERABIAN, ERICA A. BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24060	15
RABIU, SAFIANU 930 ROCKBRIDGE AVE, APT 134 NORFOLK, VA 23508	04		

SHARP, S.M. PSYCHOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	10	STINSON, ELIZABETH R. 1607 GLADE RD BLACKSBURG, VA 24060	15
SHERIDAN, PHILIP M. 2500 1/2 KENSINGTON AVE RICHMOND, VA 23220	14	STOCKETT, TAMMY 4607 RIDGE AVE 3RD FLOOR, APT D BALTIMORE, MD 21227	19
SHI, LIANG BOX 980613 RICHMOND, VA 23298-0613	09	SULLIVAN, P. KAREN PO BOX 980678 RICHMOND, VA 23298-0678	03
SHUMATE, MELISSA BOX 980599 RICHMOND, VA 23298-0599	09	SUMITRA, LEENA M. BIOLOGY DEPT PO BOX 842012 RICHMOND, VA 23284-2012	04
SKLAREW, DANA BIOLOGY DEPT GEORGE MASON UNIVERSITY FAIRFAX, VA 22030-4444	15	SUN, XINGZHONG 900W FRANKLIN ST # 334 RICHMOND, VA 23220	05
SLATER-SCHULTHEIS, ALEESIA 3482 MINTER RD ELLISTON, VA 24087-3214	04	SWAGER, MELINDA J. 551 SCARBOROUGH DR CHESAPEAKE, VA 23320	10
SMITH, E.W. PSYCHOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	10	TAN, OSMUND 728 PINEBROOK DR VIRGINIA BEACH, VA 23462	10
SMITH, BEVERLY A. BOX 980678 RICHMOND, VA 23298-0678	09	TAORMINA, JAMES P. 619 WESTOVER AVE NORFOLK, VA 23507	09
SOWERS, MICHELLE E. 2240 WILD OAK CRESCENT VIRGINIA BEACH, VA 23456	08	TATAR, N.A. PSYCHOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	10
SPEER, WILLIAM D. DEPT OF BIOLOGY VPI & SU BLACKSBURG, VA 24061-0406	14	TERRELL, CHARLES 1413 OLD BUCKROE RD A13 HAMPTON, VA 23663	
STANTON, TODD H. 4536 AIRLIE WAY ATLANTA, GA 22003-3516	10	THOMPSON, BARRY R. 725 5TH ST S BROOKINGS, SD 57006-3345	11
STEVENS, DAVID BOX 980613 RICHMOND, VA 23298-0613	09	THORNTON, SUZANNE R. 6305 MINTAWOOD CT MECHANICSVILLE, VA 23111-3719	04
STEWART, JOHN EDWARD 2115 TURTLE RUN DR # 8 RICHMOND, VA 23233	07	THORSTEINSSON, MARC V. 401 FAIRFAX RD # 1121 BLACKSBURG, VA 24060	03
STILES, JUDITH 601 FAIRVIEW AVE BLACKSBURG, VA 24060	04	TILLMAN, PATRICIA J. 3878 DARE CIRCLE # A NORFOLK, VA 23513	10

STUDENT MEMBERS

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TOWNSEND, VICTOR R. JR BIOLOGY DEPT LAFAYETTE, LA 70504	04	WARTY, NIKITA BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061-0406	03
TRIGLIO, T.S. PSYCHOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	10	WEAVER, STARLIN D. 1495 SANDY CIR BLACKSBURG, VA 24060-3772	
TRIMBUR, JOANNE PHYSICS AND COMPUTER SCIENCE DEPT CHRISTOPHER NEWPORT UNIVERSITY 50 SHOE LANE NEWPORT NEWS, VA 23606	07	WEI, DAVID BOX 980411 RICHMOND, VA 23298-0411	07
		WELLER, ED RT 1, BOX 35C CHARLOTTESVILLE, VA 22903	07
TRIPATHI, ANUBHA 9912 COLONY BLUFF DR RICHMOND, VA 23233	09	WERNER, DANIEL 3 BROOKHOLLOW DR GLEN ALLEN, VA 23060	17
TURNER, JONATHAN E. 407 FAIRFAX AVE # 101 NORFOLK, VA 23507	10	WEST, LEE PO BOX 681 BLACKSBURG, VA 24088	04
VAILHE, CHRISTOPHE 9500 G RAINBOW SPRING CT RICHMOND, VA 23294	06	WICKER, DAVID 5112 VENTURE CT APT # 202 VIRGINIA BEACH, VA 23455	10
VELAZQUEZ, DORIS 2088 SCHUBERT DR VIRGINIA BEACH, VA 23454	10	WILDER, JOHN R. 2 BRADFORD COURT FREDERICKSBURG, VA 22405	15
VENOT, DEBRA 3929 LARCHWOOD DR VIRGINIA BEACH, VA 23456	10	WILGENBUSCH, JAMES 6026 LITTLE BROOK CT CLIFTON, VA 22024	19
VIGO, ENRIQUE 6828 VANTAGE DR ALEXANDRIA, VA 22306	04	WILHITE, RHONDA E. 29 QUAIL RIDGE LN STAFFORD, VA 22554-6423	03
VILLARREAL, ADRIA N. 1336 MELROSE PKWY # 2 NORFOLK, VA 23508	10	WILKES, NICOLE 8606 GREELEY BLVD SPRINGFIELD, VA 22152	04
VOGAN, WENDY RT 1, BOX 203 BRIDGEWATER, VA 22812	02	WILLEY, CAREY P. 101 BAYVIEW AVE CAMBRIDGE, MD 21613	09
VOSHELL, JUSTIN BOX 6049 JAMES MADISON UNIVERSITY HARRISONBURG, VA 22807	02	WILLIAMS, ANITA A. 306 ESTES DRIVE EXT APT 6P CARRBORO, NC 27510-1456	08
WALTON, G. CLIFFORD 1618 CEDAR LANE POWHATAN, VA 23139	04	WILSON, C. MORGAN PO BOX 869 HAMPDEN-SYDNEY COLLEGE HAMPDEN-SYDNEY, VA 23943	04

WOLFE, JAMES 3741 GREY DOVE LANE VIRGINIA BEACH, VA 23456-5701	07
WRIGHT, SHANNON L. BIOLOGY DEPT OLD DOMINION UNIVERSITY NORFOLK, VA 23529-0266	04
WRIGHT, RACHEL 3505 MARKHAM CT VIRGINIA BEACH, VA 23456-1874	04
WRIGHT, MARK A. 9420 HOEHNS RD GLEN ALLEN, VA 24060	01
WU, ETHEL 102 LITTLE JOHN RD WILLIAMSBURG, VA 23185	16
WYNN, THOMAS C. 16 BIMINI XING APT 1 HAMPTON, VA 23666-6112	08
YANG, BIN BOX 980613 RICHMOND, VA 23298-0613	09
YIN, MEING-FEI BOX 980613 RICHMOND, VA 23298-0613	09
ZADNIK, ANDREW K. 40 THOMAS DR MANCHESTER, CT 06040	15
ZAHADAT, NAZDANEH 14317 SOUTHGATE CT WOODBIDGE, VA 22193	

LIFE MEMBERS

BANKS, WILLIAM L. PO BOX 980614 RICHMOND, VA. 23298-0614	05	FLORY, WALTER S. JR. BIOLOGY DEPT, WINSTON HALL, BOX 7325 WAKE FOREST UNIVERSITY WINSTON-SALEM, NC 27106	04
BLY, CHARLES ALBERT 777-D MOUNTAINWOOD RD CHARLOTTESVILLE, VA 22902	02	GOLDMAN, EMMA W. CHEMISTRY DEPT UNIVERSITY OF RICHMOND, VA 23173	05
BOSHER, LEWIS H. JR. 103 SENECA ROAD RICHMOND, VA 23226	09	HARSHBARGER, BOYD 213 COUNTRY CLUB DRIVE - SE BLACKSBURG, VA 24060	12
BRADLEY, GAYLEN S. PO BOX 980110 RICHMOND, VA. 23298-0110	03	HEMBREE, HOWARD W. 2034 VIEW POINT DR NAPLES, FL 33963	10
BRANDT, RICHARD B. PO BOX 980614 RICHMOND, VA 23298-0614	09	HUDGINS, WEBSTER R. 4905 AQUA LANE PRINCE GEORGE, VA 23875	05
BRUNER, B.M. 1900 LAUDERDALE DR - APT. A-314 RICHMOND, VA 23233	05	I'ANSON, HELEN BIOLOGY DEPT WASHINGTON & LEE UNIVERSITY LEXINGTON, VA 24450	04
CARPENTER, D. RAE JR. 401 OVERLOOK CIRCLE LEXINGTON, VA 24450	02	JERVIS, CHARLES K. BOX 2595 CHRISTIANSBURG, VA 24068-2595	04
CARRIER, RONALD E. OFFICE OF THE PRESIDENT JAMES MADISON UNIVERSITY SOUTH MAIN ST HARRISONBURG, VA 22807		JIMENEZ, M. A. 1604 TREBOY AVE. RICHMOND, VA 23226	01
COLEMAN, ARTHUR P. JR. PO BOX 44 RUSTBURG, VA 24588-0044	11	LIVERMORE, ARTHUR H. 5612 GLOSTER ROAD BETHESDA, MD 20816	
COLLIER, PAULA A. 1620 GROVE AVE APT 1 RICHMOND, VA 23220-4678	14	NEIL, GEORGE R. M/S 12A, 12000 JEFFERSON AVE NEWPORT NEWS, VA 23606	02
DAVIS, HUBERT J. 403 LEAVELL RD PORTSMOUTH, VA 23701		NELSON, GUY HALLIDAY 6518 ERHART RD RICHMOND, VA 23225-7108	09
DAVIS, CHARLES R. JR. P.O. BOX 91 REEDVILLE, VA 22539	11	OPP, RUTH O. 9002 BELVOIR WDS PKWY # 112 FORT BELVOIR, VA 22060-2709	05
FLAGG, RAYMOND O. 712 W. DAVIS STREET BURLINGTON, NC 27215	04	ORNDORFF, BEVERLY-SCIENCE EDITOR RICHMOND TIMES-DISPATCH 333 E. GRACE STREET RICHMOND, VA 23219	

PETERS, DANIEL J. 501-D BRIDGE CROSSING YORKTOWN, VA 23692	04	TAYLOR, GERALD R. JR. 1110 SOUTH DOGWOOD DR HARRISONBURG, VA 22801	02
ROWLETT, RUSSELL J. JR. COVENANT TOWERS 502 WEST MYRTLE BEACH, SC 29577	05	TOWNSEND, J. IVES 2931 NORTHUNBERLAND AVE RICHMOND, VA 23220-1225	09
SMART, ROBERT F. 1711 BELLEVUE AVE RICHMOND, VA 23227	04	WEST, WARWICK R. JR. 6806 LAKEWOOD DR. RICHMOND, VA 23229	04
STRUDWICK, EDMUND JR. C/O NATIONS BANK P.O. BOX 26903 RICHMOND, VA 23261		YOUNG, EDNA LOVING 181 VIRGINIA AVE DANVILLE, VA 24541-3761	04

EMERITUS MEMBERS

CAIRNS, JOHN JR. PO BOX 10661 BLACKSBURG, VA 24062-0661	04
COLMANO, GERMILLE VETERINARY BIOSCIENCES DEPT VPI & SU COLL VET MED BLACKSBURG, VA 24061	09
CRAWFORD, EDWARD A. PO BOX 184- 7076 JUANA DR MILLINGTON, TN 38053	04
HEISEY, LOWELL 22 COLLEGE WOODS DR BRIDGEWATER, VA 22812	05
LOWITZ, DAVID A. 4312 WEST FRANKLIN ST RICHMOND, VA 23221	02
SHOULDERS, JOHN F. 509 MONTE VISTA DR. SW BLACKSBURG, VA 24060	01

CONTRIBUTING MEMBERS

ABBOTT, LYNN D. JR. 607 HORSEPEN RD RICHMOND, VA 23229	09	DORR, JOHN VAN N. II MRS. 9707 OLD GEORGETOWN RD APT 2514 BETHESDA, MD 20814-7037	08
ALLEN, J. FRANCES RR1, BOX 9 ROOSEVELT AVE ROXBURY, NY 12474-9779	04	ENGLISH, BRUCE V. P.O. BOX 267 ASHLAND, VA 23005	
BONNER, CARL E. JR NORFOLK STATE UNIVERSITY 2401 CORPREW AVE NORFOLK, VA 23504	05	FABRYCKY, W. J. PROF OF ISE VPI & SU BLACKSBURG, VA 24061	07
BURTON, WILLARD W. 6808 GREENVALE DR RICHMOND, VA 23225	05	FAUL, SCOTT B. 4059 TIMBER RIDGE DR VIRGINIA BEACH, VA 23455-7018	09
CAMPBELL, ADDISON D. 8520 JULIAN ROAD RICHMOND, VA 23229	02	FISHER, CHARLES H. 2546 SOUTH CLEARING RD SALEM, VA 24153	05
CAULEY, LINDA N. ROUTE 1, BOX 265 FISHERSVILLE, VA 22939	15	FISHER, LYMAN M. 9202 WATERLOO COURT RICHMOND, VA 23229	09
CHRISTMAN, CAROLE W. 4109 EXETER RD RICHMOND, VA 23221	09	FOY, M. L. GRAYSON 2811 GROVE AVE RICHMOND, VA 23221	02
CLAUS, GEORGE WILLIAM BIOLOGY DEPT VPI & SU BLACKSBURG, VA 24061-0406	03	FUNSTEN, HERBERT O. 116 MILL NECK RD WILLIAMSBURG, VA 23185	02
COGBILL, E. C. 1600 WESTWOOD AVE, APT E202-204 RICHMOND, VA 23227	05	GASKINS, RAY A. P.O. BOX 311 HAMPDEN-SYDNEY, VA 23943	12
COLEMAN, DOUG EXECUTIVE DIRECTOR WINTERGREEN NATURE FOUNDA- TION NELLYSFORD, VA 22958		GOULD, HENRY W. MATHEMATICS DEPT WEST VIRGINIA UNIVERSITY MORGANTOWN, WV 26506	02
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